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THE CONTRACT FOR THE ALBANY WATER FILtration plant, described at length in our issue of Feb. 10, has been awarded to Mr. Henry Dumary, of Albany, and the Wilson & Baillie Manufacturing Co., of New York city, for $309,866. The engineer's estimate was $322,440. Ten bids were received, the highest being $387,345. The detailed bids are given elsewhere in this issue under Contract Prices. The plant includes eight masonry-covered filter beds with an available area of about 0.7 acres each and a daily capacity of 15,000,000 gallons; also a 16,000,000-gallon sedimentation basin, without a roof; a 600,000-gallon covered pure water reservoir; and a sand-washing apparatus, pipe system, regulating houses and building for a bacteriological laboratory. This is by far the most important water filtration plant ever contracted for in this country, but probably others equally large and perhaps much larger will be built within a few years. Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., St. Paul Building, New York city, is chief engineer for the work, and Mr. Geo. I. Bailey is superintendent of water-works.

A WIRE ROPE TRAMWAY, to be operated by electricity, will be erected over the Chilkoot Pass in Alaska. The scheme was developed by the Dyea-Klondike Transportation Co., who let the contract for the generators, motors and other electrical apparatus to the Westinghouse Electric and Manufacturing Co., Pittsburg, Pa. Two sections will be used, one 12 miles long, operated by a 30-HP. motor at the far end, and the other one mile long, driven by a 15-HP. motor. The generator, a 45-K-W., two-phase machine, operated by steam, will supply current to two 25 K-W. step-up transformers, which will raise the voltage to 5,000 volts three-phase. Four 10-K-W. step-down transformers, two for each motor, are also included in the equipment.

THE KUHLMANN COUNTERWEIGHT SYSTEM for helping street cars up grades or holding them in check while descending will be employed by the St. Paul Street Ry. Co. This system was described in our issue of June 29, 1893. Briefly, it consists of a cable running in a conduit, as in the ordinary cable road. Under this is a second conduit, in which a heavy counterweight runs upon a suitable track. The cable turns back upon itself at the top and bottom of the hill and is attached to this counterweight after running over a suitable slack takeup. The cars are provided with a grip which seizes the cable when descending and hauls the counterweight up hill. A car wishing to ascend grasps the cable and is assisted up by the weight descending. The system was first used in Seattle, Wash., on a 16% grade, the same as that in St. Paul. It is also used in Providence, R. I., but the grade in that city is only 14%.

THE ELECTRICAL EXPOSITION to be held at Madison Square Garden, New York city, May 2-31, promises to be very successful, and already over 100 prominent electrical engineering or manufacturing firms have secured space for exhibits. From present indications the generating plant supplying power to the different exhibits will contain at least 20 units, equally divided between gas, oil and steam engines. An auxiliary and educational committee will work in conjunction with the New York Electrical Society, under whose auspices the exposition will be held, and a very interesting series of lectures will be arranged for. The attendance at the 1896 exhibition was over 300,000, and it is confidently expected that the number will reach 1,000,000 during the 1898 exhibition.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Feb. 18 on the Santa Fe Pacific R. R., about six miles east of Kramer, Cal. According to reports an eastbound passenger train collided head on with a westbound passenger train, killing both engineers and badly shaking up the passengers.

THE SECOND-CLASS BATTLESHIP "MAINE," destroyed in Havana Harbor on Feb. 15, from a cause yet undiscovered, had the following dimensions and armament: Length on load water line, 318 ft.; extreme beam, 57 ft.; mean draft, 21 ft. 6 ins.; displacement, 6,682 tons; gross tonnage, 3,933. Her engines were twin-screw, vertical triple expansion, of 9,293 max. I. HP., and her speed was 17.45 knots per hour. Her armament was made up of four 10-in. and six 6-in. breech-loading rifles; and in her secondary battery she had seven 6 pdr. and eight 1 pdr. rapid-fire guns and four Gatling guns. Her side armor was 12 ins. thick; turrets, 8 ins., and barbettes, 12 and 10 ins., with a flat protection deck 2 ins. thick. Her full complement of crew was 37 officers and 343 men. The keel of the "Maine" was laid at the Brooklyn Navy Yard on Oct. 17, 1888, and she was launched on Nov. 18, 1890, and commissioned Sept. 17, 1895. The cost of the hull and machinery was $2,500,000. Her normal coal supply was 400 tons, with a bunker capacity of 896 tons. The only other vessel of her class built by the government is the "Texas," of 4,050 tons gross tonnage, and 6,315 tons displacement, launched in 1892. The "Texas," however, has two 12-in. guns and a much heavier secondary battery, with 12-in. armor on her sides and turrets.

A CONTRACT FOR AMERICAN ARMOR PLATE, for the Russian battleships "Peresvet" and "Olysibia," of 12,840 tons each, has been awarded to the Carnegie Co., at $500 per ton. Bids for this armor were received from leading English, French and German firms, as follows: Vickers and Brown plates, $583.96 and $569.38 per ton, respectively; St. Chamond, $490 to $569, according to thickness; Creusot, $478.64 to $569; Chatillon, $486 to $563.50; Krupp, $562.52 for all sizes; Dillingen, $559.30, and Austria offered Wilkowitz plates for $452.50 for all sizes. The original bid of the Bethlehem and Carnegie companies was $530.45 for all sizes; or, a little less than the $533.12 obtained by the Carnegie Co. for its previous Russian contract. Russia rejected all the bids, and then made a bargain with the Carnegie Co. for $500 per ton for Harvey super-carbonized plates.

THE YACHT "NIAGARA," built for Howard Gould, by the Harlan & Hollingsworth Co., of Wilmington, Del., is claimed to be the largest pleasure vessel ever constructed in the United States. The "Niagara," launched on Feb. 19, is 272 ft. long over all, 247 ft. at the water line, and 36 ft. beam. The depth to main deck is 19 ft. 4 ins., and draft, 16 ft. The displacement is 1,900 tons, and she is bark-rigged, with double-bottom and three decks. The two engines operating her twin screws are triple expansion, inverted cylinder, direct acting and surface condensing and use steam at 160 lbs. pressure. The cylinders are 18, 28 and 45 ins., with 30-in. stroke. Steam is furnished by three Scotch boilers; and the coal storage capacity is 450 tons. The guaranteed speed is only 14 knots per hour, as the owner prefers comfort to speed. A very complete electric plant is included, capable of supplying 400 16-c. p. lamps. The "Niagara" will be completed by May 15 and carry a crew of 60 men. No estimate of cost is given; but it is said that the yearly running expenses will be about $100,000.

COTTON BALING AND COTTON FIRES are reported upon by by U. S. Consul James Boyle, of Liverpool. A late test has been made of the comparative merits of the square and cylindrical American cotton bale with regard to the effect of fire upon them. The two bales were fired and burned side by side for 30 minutes. The square bale originally weighed 410 lbs., and 261 lbs. of sound cotton were recovered, showing a loss of 36.3% of the whole. The cylindrical bale weighed 504 lbs., and 392 lbs. remained sound; showing a loss of 22.2%, though consideration must be given to the relative sizes of the bales. The bulk of evidence was in favor of the round bale, which weighed 35 lbs. to the cubic foot, while the square bale weighed about 25 lbs. The Egyptian and Brazilian cotton bales weigh 45 lbs. per cu. ft., and never give trouble from fire or by damage to the jute covering. The explanation of the liability of the square American cotton bales to fire is thus given: The American compress is as powerful as any in the world, and the bales are first compressed to 45 lbs. per cu. ft.; but after the ties are made fast the bale is allowed to expand against the ties and in doing so sucks in a great quantity of air. An American bale treated in this way is one system of oxygen cells, and the fire once started follows these cells and is difficult to put out. On the other hand, the Egyptian bale is likewise compressed to 45 lbs., but is held to that density by a sufficient number of steel ties; there are four or five more bands around an Egyptian bale than around an American bale. The trouble lies in the baling, and is accounted for by the fact that the Egyptian, Indian and Brazilian baling is done by those who get the advantage of superior compression in freight and insurance; while the American baling is done in the cotton-belt by persons not interested in these advantages. The principal objection to the cylindrical bale comes from its stowing defects, as urged from a shipping and insurance standpoint. It is claimed that the spaces left in stowing form air-drafts, dangerous in case of fire, and this space is waste space. The latter point is met by the greater density of the round bale. Another objection is that the cotton in the round bale is rolled, while in the old bale it is in layers, and is thus easier to sample and to use by the spinners.

THE SUGAR PRODUCTION OF EUROPE in 1897-98, according to U. S. Consul H. W. Diederick, of Magdeburg, is given as follows in "tonnes" of 2,204 lbs.:

Country.	No. of factories.	Tonnes.
Germany	402	1,885,555
Austria-Hungary	215	836,540
France	348	779,800
Belgium	111	231,000
Holland	31	118,000
Russia	239	740,000
Sweden	16	86,000
Totals	1,362	4,596,695

Of course, a very large part of this is beet-sugar, the countries named using over 26 million tons of sugar-beets in this process in the period named. The figures given for the fiscal year 1897-98 are necessarily approximate. The official total product of sugar for the year 1896-97 was 4,731,223 tonnes for the countries named. The sugar-cane product for all countries is given separately as amounting to 2,460,000 tons for 1897-98. Of this the United States produced 345,000 tons; Java, 560,000 tons; Cuba, 200,000; Sandwich Islands, 200,000 tons; Brazil, 180,000; Phillipine Islands, 190,000 tons; Mauritius and Demerara, 110,000 tons each, and Egypt, 100,000 tons.

THE FOREIGN TRADE OF 1897, in agricultural products of the United States, is reported upon by the Department of Agriculture. The total exports for the year amounted in value to $1,032,007,603, outstripping all previous records. Of this total 69.84%, or $689,755,193, had its origin in agriculture, a gain of $115,356,929 over 1896, or about 20%. The total imports into the United States in 1897 had a value of $764,730,412; of which 52.42%, or $400,871,468, was represented by agricultural products, and largely made up of extraordinary imports of raw sugar and wool in anticipation of the new tariff.

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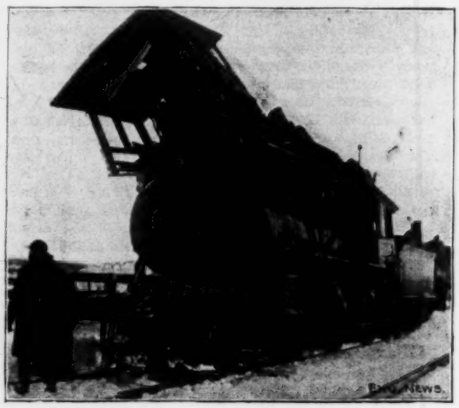
Item.	1896.	1897.	Increase.
Cotton, lbs	2,335,226,385	3,103,754,949	768,528,564
Wheat, bushels ...	60,650,080	79,562,020	18,911,940
Av. wheat price..	65.5 cts.	75.3 cts.	9.8 cts.
Indian corn, bu...	.....	176,916,395	75,000,000
Av. corn price...	37.8 cts.	30.6 cts.	.....
Corn meal, bbls..	276,885	475,263	198,378
Oats, bushels	.....	.....	22,000,000
Barley, "	.....	.....	13,000,000
Rye, "	.....	.....	8,000,000
Flaxseed, bushels..	80,453	4,713,747	4,633,294
Cattle, head ...	372,461	392,190	19,729
Horses, "	25,196	39,532	14,336
Fresh beef, lbs....	224,783,225	290,395,930	65,612,705
Bacon, lbs	425,352,187	500,399,448	75,047,259

THE CHINESE RAILWAY-SYSTEM, says U. S. Consul John Goodnow, of Shanghai, is made up of two lines aggregating 293 miles in length. One is the Tientsin-Peking line, 79.7 miles long; the other is the Tientsin-Chunghon-so line, 214 miles long. On the first there is one passenger train daily each way, and five mixed trains running over parts of the line. The operatives are practically all Chinamen, and no foreigner can compete with them. The highest paid man is the telegraph operator, at $17.80 gold per month; engine-drivers receive $8.90 to $13.38 gold per month; brakesmen, section hands and laborers receive $2.68 to $4.46 gold per month. The fare on the Tientsin-Pekin line is approximately 1.55 cts. gold per mile; on the other road it is 1.10 cts. gold. A railway from Shanghai to Woosung, 14 miles, is now being built by the Chinese themselves; the grading is about finished. The comprehensive plan of Sheng, Director General of the Imperial Chinese railway administration, calls for a trunk line, 1,500 miles long, from Peking to Canton; a line from Shanghai up the Yangtie Valley, 2,500 miles, and a line west from Canton, 1,500 miles. But these line are all "in the air"; they will only be built if money can be borrowed for them outside of China. Sheng also proposes to couple with these railway loans one of $80,000,000 to pay the Japanese indemnity. There is thus no market for American labor in China unless American capitalists first invest largely.

A REMARKABLE BUTTING COLLISION

The photographs reproduced herewith show the remarkable result of a head collision which occurred near Hospital Station, on the Northern Division of the Old Colony System of the New York, New Haven & Hartford R. R., during the severe snow storm of Jan. 31. How the two locomotives got into the situation shown by the photograph with such small injury to each other is a puzzle which we will not attempt to solve. The accident should certainly be encouraging to the genius who proposed to permit trains to pass each other on the same track by equipping the trains running in one direction with inclines at front and rear, and a track laid upon them and over the roofs of the cars.

We understand the two locomotives were hauled several miles in the position shown in the photographs. For the views from which our illustrations are reproduced, we are indebted to Mr. N. S. Brock, C. E., of Boston.



THE RESULT OF A BUTTING COLLISION IN A SNOW STORM, NORTHERN DIVISION, OLD COLONY R. R., JAN. 31, 1898.

TESTS OF AN ELECTRIC COAL MINING PLANT.

During the winter of 1895-6 a coal mining plant was installed by the Link Belt Machinery Co., of Chicago, at the Angle Colliery, of the Norfolk Coal & Coke Co., at Maybeury, W. Va. It consisted of two 100-HP. return tubular boilers, a 125-HP. McEwen automatic engine, a 75-K-W. "Independent" generator, an 80-HP. haulage motor, a 25-HP. motor on a "larry," a 15-HP. electric chain breast coal crushing machine, a 3-HP. enclosed motor and pump, and a 2-HP. emery grinder and motor, together with all the necessary fittings, both steam and electrical. During the summer of 1896 a somewhat elaborate test was made of all this machinery, by Messrs. Clifford Buck and Clay Belsley, then students at Sibley College, Cornell University, and their complete report was presented by them as a thesis for the degree of mechanical engineer in June, 1897. The tests were made to investigate the actual every-day performance of the several machines under the working conditions of the mining plant, when handled by the regular men in charge. No preparatory cleaning or overhauling of the machines were made. The thesis is an unusually fine piece of work of its class, and the results are of interest in showing, what is ordinarily difficult to obtain, the records of performance and efficiencies of electric driven apparatus under the extremely fluctuating and unfavorable conditions of actual work in a coal mine. It makes a book of 246 type-written pages with numerous diagrams, photographs, etc. We give below a condenced abstract of the principal results obtained from the tests.

Boiler Tests.

Two horizontal return tubular boilers, 18 ft. long, 66 ins. diameter, 60 4-in. tubes. Heating surface of two boilers, 2,300 sq. ft. Grate surface, 56 sq. ft.

The probable reason for the greater efficiency on the last day's test is that the foreman had been in the habit of using bone coal, and consequently fired the boilers too heavily on the first day's test.

(These results are of interest chiefly in showing how low a boiler efficiency may be obtained when using a first-class steam coal if the boiler is driven at a slow rate. The rate of driving during these tests was only about one-third of the rating of the boilers (200 HP.).—Ed. Eng. News.)

	Test		
Kind of coal	No. 1. Run mine, Angle colliery.	No. 2. Outcrop, Delta col'ry.	No. 3. "Bone."
Moisture in coal, %.	6	3	0.96
Ash in coal, %.	6.40	8.8	16.6
Coal burned per sq. ft. of grate per hour, lbs.	6.94	6.12	5.75
Water evap. from and at 212°:			
Sq.ft.htg surf.,pr hr.,lbs.	1.27	1.02	0.81
Per lb. of coal, lbs.	7.368	6.75	6.72
Per lb. combustible, lbs.	8.48	7.65	8.13
Efficiency of boiler, %	51.35	48.75	52.70
HP. developed	83.4	67.	62.5

Engine Tests.

The engine was a 14 × 16-in. McEwen automatic, non-condensing, rated at 125 HP., with 80 lbs. initial pressure and 244 revolutions per minute.

	Test		
	No. 1.	No. 2.	No. 3.
Friction of engine, HP.	4.63	....	....
" " belt.	0.77	....	....
" " dynamo.	0.68	....	....
Engine, belt, dynamo.	6.08	....	....
St'm press. at throttle,lbs.	97.2	79.7	61.5
I. HP. developed....From	11.42	4.22	9.89
To...	80.99	125.35	111.55
I. HP., average.	34.99	32.50	34.09
Mechanical efficiency, %..	86.6	85.9	86.4
Water pr I. HP. pr hr.,lbs	70.5	60.64	54.4
Coal, pr I. HP. pr hr.,lbs.	11.08	10.53	9.45
Cmbstible, I.HP.pr.hr.,lbs.	9.71	9.29	7.77

Remarks on the Engine Tests.—The water consumption was very high. The frictional horsepower was very low, being only 4.63 HP. This indicates looseness of piston or valve, or both, and consequent steam leakage. The actual load on the engine was between one-third and one-fourth of its rating. The consumption of steam went down as the pressure went down. A reduction of boiler pressure to as low a figure as would turn the engine over at the required speed would bring the point of cut-off to where the engine would give a fairly good performance.

Dynamo Test.

The voltmeter and ammeter readings were recorded every minute throughout the test, and the speed was recorded every five minutes. The speed, in test No. 1, varied between 242 and 289 r. p. m., averaging 252.5. The voltage ranged between 245 and 335, the average of the one minute readings being 280, and of the five minute readings, 272.5. The amperes ranged between 0 and 220, the average of one minute readings being 50 and of five minute readings, 58.7. The average E. H. P. calculated from the one minute readings was 18.78, and from the five minute readings, 21.44. The following is a summary of the average results of the three tests:

		Volts.	Amperes.	E. HP.
Test No. 1.	1-min. reading	280.0	50.0	18.76
"	5-min. "	272.5	58.7	21.44
" 2.	5-min. "	264.0	63.65	22.52
" 3.	5-min. "	271.7	59.0	21.48

Remarks.—The efficiency of the dynamo on the three tests under working conditions is somewhat below what would be expected from the efficiency curve plotted from the results of the tests with water resistance. The discrepancy is, no doubt, due to the fact that the engine could not respond instantaneously to the fluctuations of the demands on the dynamo.

Efficiencies.

The several efficiencies of the boiler, engine and dynamo are calculated from the following data:

A. Heat generated in furnace, B. T. U. per hour.
B. Heat absorbed, dry steam, B. T. U. per hour.
C. Heat delivered to engine, dry steam, B. T. U. per hour.
D. Heat utilized by engine, I. H. P.
E. Work delivered by engine, D. H. P.
F. Work delivered to dynamo.
G. Work done by dynamo, E. H. P.

In working out the heat equivalent of a horse-power is taken as the expenditure of 2,545 B. T. U. per hour.

The following efficiencies were obtained in the three tests:

		Efficiencies per cent. Test		
		No. 1.	No. 2.	No. 3.
Boiler	B ÷ A	51.35	48.75	52.70
Engine, thermal	D ÷ C	3.10	3.71	4.216
Engine, mechanical	E ÷ D	86.6	85.9	86.40
Dynamo	G ÷ F	73.78	83.05	74.75
Boiler and engine.	D ÷ A	1.542	1.803	2.188
Engine and dynamo,	G ÷ D	61.27	69.23	63.00
Station, total	G ÷ A	0.943	1.250	1.375

(The last line shows that of the total heating value of the fuel only from 0.943 to 1.375% was obtained in the shape of electric current delivered by the dynamo. The principal causes of the low efficiency evidently are 1, the boiler was driven at a rate far below its rating; 2, the average engine and dynamo load were far below their most economical loads; 3, the loads were extremely fluctuating.—Ed. Eng. News.)

Water Resistance Runs.

In these runs the load was held constant by means of a water resistance, and the engine was indicated. The load was increased by increments of 20 amperes, cards being taken for each load. The water resistance consisted of a wooden tank, 3 × 2 × 1½-ft., filled with water, and having metal plates at terminals, one plate being fastened to one end of the box and the other movable. The conductivity of the water was increased by the addition of salt and cooking soda. After each addition of salt and soda the distance between the plates was changed until the meters showed the required load. The speed of engine during these runs averaged 244.3, and the volts ranged from 265 to 275.

Summary of Results, Water Resistance Runs.

Test, No.	Indicated HP. Head.	Crank.	Total.	Dynamo. Amperes.	E. HP.	D. HP.	Efficiencies. Dynamo.	Station.
1.	6.18	10.36	16.54	20	7.24	11.14	65.0	43.8
2.	11.56	13.77	25.33	40	14.50	19.93	72.7	57.3
3.	15.64	16.26	31.90	60	21.90	26.50	82.6	68.8
4.	19.60	19.30	38.90	80	28.54	33.50	85.2	73.4
5.	23.20	23.10	46.30	100	35.50	40.90	86.7	76.5
6.	27.90	27.80	55.70	120	43.20	50.30	86.0	77.6
7.	32.40	32.30	64.70	140	51.00	59.30	86.0	78.9
8.	38.00	37.40	75.40	160	58.30	70.00	83.5	77.5
9.	42.10	40.00	82.10	180	66.10	76.70	86.2	80.6
10.	45.50	44.80	90.30	200	73.40	84.90	86.5	81.4
11.	51.35	49.95	101.30	220	81.09	95.90	85.4	80.7
12.	56.50	52.90	109.40	240	88.47	105.00	84.2	80.7
13.	63.90	58.70	122.60	260	95.84	117.20	81.5	78.1

Fig. 1 shows the relation of the dynamo and station efficiencies to the electric horse-power developed, and Fig. 2 the external characteristic of the dynamo, or the relation between the pressure across the terminals of the dynamo and the current in the exposed circuit.

Power Required by an Electric Chain Breast Coal Cutting Machine.

A coal cutting machine, known as the "Independent Chain Breast Machine," made by the Link Belt Co., was tested. The machine is geared so that it may feed fast or slow so as to cut in soft or in hard coal, as the case may be. In the test it was geared slow, for cutting in bony coal. When the end of a cut is made the feed is reversed and a new set of gears is thrown in, causing the machine to come out in about one-fifth of the time it takes to go in. The motor is a bipolar shunt-wound machine of 15 HP., armature speed 132. The accompanying table gives a summary of the results. During the tests volt and ammeter readings were made every five seconds. Run No. 1 was made in medium coal, No. 2 in soft, and No. 3 in hard coal.

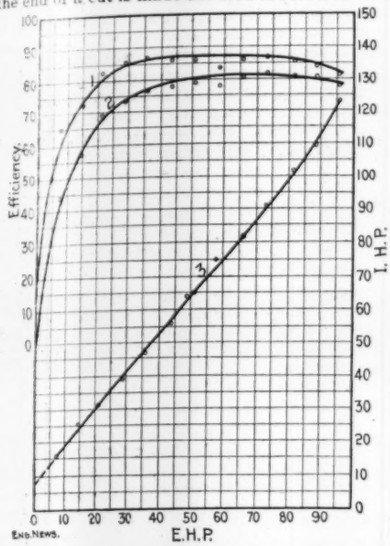


Fig. 1.—Relation of Dynamo and Station Efficiencies to Electric Horse-Power Developed.

(1. Dynamo Efficiency; 2. Station Efficiency; 3. E. H. P. = I. H. P.)

Remarks on the Coal Cutter.—The power of the motor is amply sufficient for the demands made upon it. The slow feed was put on the machine so that it could be used in bone, but it was found unsatisfactory for this purpose, and was put to cutting the good coal. The machine could easily stand a feed half again as fast without overtaxing it. The results of the tests, as well as the experience of the Coal Co. show that the machine is working in a very satisfactory way.

Test of a Mine Haulage Motor.

A test was made of a 10-ton 80-HP. haulage motor. It is a single reduction motor, the axis of the armature lying in the direction of the track, and both pairs of driving wheels are geared to it by bevel gears. It is claimed by the manufacturers that this arrangement gives a better drawbar pull at starting than two independent motors would give. The tests were made over an entry track in which the grade is against the load. The object of the tests was to obtain the efficiencies and the speeds of the motor under various loads. To get the speeds the times required to run between whitewash marks placed 100 ft. apart on the side walls were taken with a stop watch. To get the electrical horse-power a voltmeter was connected between the trolley and ground, and an ammeter was connected in the main circuit. To obtain the draw bar pull a Giddings' traction dynamometer was used. The loads were varied by varying the number of cars hauled.

In addition to the regular tests a drop run was made, simultaneous voltmeter readings being taken in the station and on the motor. This gave the per cent drop on the line. The accompanying table gives a summary of some of the results:

Remarks on the Haulage Motor.—During the tests the rails were slippery from dampness and coal dust, and consequently there was a great deal of slipping of the drivers. Sand had to be used freely. So far the motor has been able to meet all the demands made upon it, although it does not come entirely up to the guarantee as regards number of cars and speed. It is, however, handicapped to a great extent by the slippery rails.

Summary of Results of Electric Mine-Haulage Motor Tests at Angle Colliery, Maybeury, W. Va.

Condition of run.	Drawing loaded cars. In main entry.		Drawing loaded cars. Out shot 8.		Drawing empty cars. In main entry.	
A. Run number	2	4	5	6	10	11
B. Number of cars	3	7	7	9	10	16
C. Drawbar pull, average lbs.	836	1,920	1,530	1,980	835	1,300
D. Pull per car, lbs.	259	252	210	213	77.5	77.5
E. Distance run, ft.	2,400	2,300	550	500	2,300	2,300
F. Time of run, secs.	250	360	103	98	276	310
G. Speed, ft. per sec.	9.6	6.4	5.34	5.1	8.33	7.43
H. Speed, miles per hour	6.55	4.36	3.65	3.49	5.71	5.09
I. Frictional resistance of motor, lbs.	465	465	675	675	465	465
J. E. HP. delivered to motor	24.25	34.21	33.35	44.10	25.85	28.80
K. Dynamometric, HP.	14.52	22.30	14.80	18.40	12.60	17.53
L. Loss, HP.	9.73	11.91	18.55	25.70	13.25	11.27
M. Efficiency, %	60.0	65.0	44.4	41.7	48.80	61.00
N. HP. consumed by motor friction	8.1	5.15	6.53	6.26	7.04	6.27
O. Loss, electrical + slip of wheels, HP.	1.63	6.76	12.02	18.44	6.21	5.00
P. Grade of track, average %	1	1	2	2	1	1
Q. Maximum drawbar pull, lbs.	4,400	.....	3,075	5,700	.....	5,400

Note.—In each case a dynamometer car was hauled between train and locomotive. This was equivalent to one empty car.

Derivation of Results in Table.

B. Number of cars in train, not counting dynamometer car.
C. Obtained from traction dynamometer.
D. Item C — 60 lbs. (dynamometer car pull) ÷ B.
I. Taken from dynamometer record, taken when the motor was drawn over the line by mules.
K. (C × E) ÷ (F × 550).
L. J — K.
M. J ÷ K.
N. (I × E) ÷ (550 × F).
O. L — N. This varies considerably on account of wheels slipping.
P. From survey of track.

Shop Test of the Haulage Motor.

A shop test of the haulage motor was made, giving the following results, 250 volts, 250 amperes = 86.7 HP. delivered to the machine. Speed, 8.56 miles per hour:

Gear loss, 5.52 HP. = 6.36% Losses, 20.92 HP. = 24.12%
Elec. loss, 9.70 HP. = 11.19% Wrk done, 65.78HP. = 75.88%
Rolling friction, 5.70 HP. = 6.57%.

Draw bar pull calculated from 65.78 HP., at 8.56 miles per hour = 2,880 lbs. Measured draw bar pull, 2,700 lbs., equal to 61.66 HP., or 71.11% efficiency, 75.88 — 71.11 = 4.77% loss unaccounted for, representing the difference between 2,880 and 2,700 lbs. draw bar pull.

Tests of a Motor Larry.

The "larry" is a large sheet-iron hopper, mounted on a truck. It is used to take the slack to the coke ovens. The grade of the track is so heavy that two mules were required to draw it when loaded. It is fitted with a 25-HP. series-wound motor. In all, 21 runs were made, with the larry both loaded and empty. Readings of time, volts and amperes were taken on passing the poles, which were 25 ft. apart. In a special run on a heavy grade, with the larry loaded, the maximum power exerted was 55 HP. When the runs were completed a pair of mules was attached to the larry through a traction dynamometer, and it was pulled over the track. The dynamometer pull was taken as the frictional resistance of the whole machine.

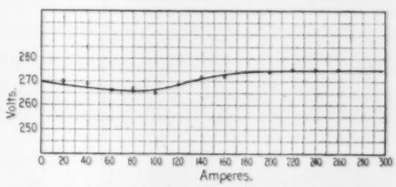


Fig. 2.—External Characteristic of the Dynamo.

In starting the loaded larry the mules exerted a steady pull of 1,950 lbs.—a remarkable figure. The loaded larry weighs about 14 tons.

The electric larry is an innovation, this one being the first ever tried. It does its work in a satisfactory manner.

The following table is a summary of the larry tests:

Summary of the Larry Tests.

	Test No. 1.	Test No. 2.	Test No. 3.
A. Run			
B. E. HP. deliv. motor	10.94	11.40	14.96
C. Distance run, ft.	475	475	475
D. Time in seconds	66	64	79.5
E. Frictnl resistnce, lbs.	500	500	790
F. HP. dev. ovrcmg fric	6.54	6.75	8.60
G. Electrical loss, HP.	4.40	4.65	6.36
H. Speed, ft. per sec.	7.2	7.43	5.97
I. Speed, miles per hr.	4.94	5.1	4.09
J. Efficiency motor, %.	59.7	59.1	57.5
K. Start'g resistance, lbs.	1,500	1,500	1,950

Derivation of Results.

E. From dynamometer record taken by drawing larry over track with mules.
F. (E × C) ÷ (550 × D).
G. B — F.
J. F ÷ B.
K. From maximum dynamometer reading at start.

Test of an Electric Rotary Pump.

The pump tested was a small Rumsey rotary, No. 4 size, geared 9 to 1, to an "Independent" motor. It was used to pump out low places in the mine, and was mounted on a truck, so that it could be moved from place to place. The head pumped against was measured by a steam gage connected to the discharge. The suction head was measured by leveling. Volt and ammeter readings were taken every half-minute for an hour and a-half. The water discharged was measured in calibrated barrels. The following are the principal results:

Average, E. HP.	2.04
Discharge head, ft.	44.5
Suction head, ft.	6.5
Water pumped per minute, lbs.	328
Horse-power, work done	0.505
E. HP. running free	1.13
Revolutions of armature, per min	1,700
Revolutions of pump, per min.	189
Slip of pumps, %	30
Horse-power represented by slip	.218
Horse-power unaccounted for	.189
Efficiency of whole apparatus, %	24.8

Summary of Coal Cutter Tests.

Height of cut, 4.5 ins. Width of cut, 3.5 ft. Depth of cut, 6.08 ft. Sq. ft. cut, 21.28. Armature speed, 1,320.

Run.	Cut.	Time, minutes. In.	Out.	Tot'l.	Electrical horse-power. In. Maximum.	Mini-mum.	Aver-age.	Out, average.	To overcome friction. Feed. On.	Off.		Net to feed cut.	To cut 1 sq. ft. in 1 min.	Voltage.
1.	a	5.00	1.15	6.15	15.00	5.15	12.87	6.65	4.30	3.75	0.55	8.57	6.31	263
1.	b	4.25	1.00	5.25	13.95	4.35	9.60	6.45	4.40	3.75	.65	5.20	5.44	246
1.	c	4.25	.87	5.12	13.49	5.02	8.77	7.57	4.40	3.75	.65	4.37	5.27	245
1.	d	4.00	1.00	5.00	12.68	4.02	10.00	7.43	4.44	3.75	.69	5.56	5.49	243
1.	e	3.87	1.00	4.87	15.40	5.48	10.60	7.28	4.46	3.75	.71	6.14	5.57	247
	Average	4.26	1.00	5.28	14.10	4.80	10.37	7.08	4.40	3.75	0.65	5.97	5.62	249
2.	a	4.16	1.08	5.24	13.30	3.98	9.66	5.26	4.43	3.75	0.68	5.23	5.29	258
2.	b	4.00	.91	4.91	12.08	5.05	8.68	5.98	4.44	3.75	.69	4.24	5.22	259
2.	c	3.92	1.00	4.92	12.34	4.64	9.33	6.98	4.45	3.75	.70	4.88	5.34	249
2.	d	4.93	1.08	6.01	11.59	5.56	9.56	6.36	4.31	3.75	.56	5.25	5.52	253
	Average	4.25	1.02	5.27	12.33	4.81	9.31	6.14	4.41	3.75	0.66	4.90	5.34	253
3.	a	3.87	.92	4.79	13.85	4.34	9.86	6.42	4.46	3.75	0.71	5.40	5.44	263
3.	b	3.90	1.00	4.90	10.65	4.10	8.36	5.64	4.45	3.75	.70	3.91	5.17	260
3.	c	4.08	.92	5.00	13.30	3.26	9.50	5.35	4.44	3.75	.69	5.08	5.41	253
3.	d	3.85	1.00	4.85	11.40	4.17	8.94	5.20	4.46	3.75	.71	4.48	5.27	253
3.	e	3.83	.92	4.75	12.05	3.75	9.02	5.64	4.46	3.75	.71	4.56	5.28	249
	Average	3.91	.95	4.86	12.25	3.91	9.14	5.65	4.45	3.75	0.70	4.68	5.31	256
	Ave. of averages	4.14	.99	5.14	12.89	4.51	9.61	6.29	4.42	3.75	0.67	5.18	5.42	253

Bits had been running a week when machine was tested.

Test of an Electric-Driven Emery Grinder.

The emery grinder consists of a completely encased 2-HP. motor driving two 10 × 12-in. emery wheels mounted on the armature shaft which is run at a speed of 1,900 r. p. m. It is used to grind the bits for the chain breast machine. During the test voltmeter and ammeter readings were taken every five minutes while the blacksmith ground off a piece of wrought iron. The principal results are as follows:

Average, E. HP.	1.92
Average E. HP. running free	1.08
HP. available for grinding	0.84
Size of wheel ..... diameter, 9.5 ins.; face,	2 ins.
Speed, revolutions per min.	1,892
Time to remove 1 oz. of iron	4 mins.
Rim velocity of wheel, ft. per min.	4,700
Wrought iron removed per mile of rim, oz.	0.28

General Remarks on the Whole Plant.

It must be remembered that in a plant of this kind economy of operation is not of so much importance as low first cost, as fuel costs almost nothing. Regulation is an important desideratum and this seems to have been obtained. All things considered, the plant is doing very well.

CHANGING A CABLE STREET RAILWAY TO A CONDUIT ELECTRIC SYSTEM IN WASHINGTON, D. C.

(With two-page plate.)

In accordance with a progressive policy, as well as to meet the requirements of an act of Congress, the Capitol Traction Co., of Washington, D. C., some years ago installed a cable system on its 7th St. line. A substantial road bed, including some 3⅓ miles of double track, and a power house containing the latest forms of cable machinery was installed. The operation of this road proved so satisfactory that the company changed over its Avenue, Georgetown and 14th street sections (Fig. 1), amounting to about 7¾ miles of double track, and, as in the case of the 7th Street line, advantage was taken of former experience and only the latest and best plans and materials were adopted.

A suitable site was obtained in a central portion of the city, and a substantial six-story brick power house, 241 × 185 ft., was erected. The boiler-room, coal storage, repair shop, necessary space for machinery and the offices of the company occupied the whole lower floor, while the entire upper portion was rented to printers, light machine shops, laundries, etc.

Until recently the entire plant gave excellent satisfaction, and the idea of changing to an electric system, while it may have been considered, was not contemplated for some time to come. On Sept. 30, 1897, this large power station was completely destroyed by fire (Eng. News, Oct. 7, 1897), thus stopping the three cables which radiated from this one point. The almost perfect working of the conduit electric system as operated by the Metropolitan road of that city, and the necessity of building a new power house and ordering new machinery in any case determined the directors to adopt the conduit electric system, and work was at once begun upon the necessary changes.

A trench was excavated between the tracks and National Conduit & Cable Co.'s conduits and Camp terra cotta ducts were laid the entire length of the track. The former are sheet iron cement-lined pipes, 8 ft. long and 3¼ ins. inside diameter, while the latter are terra cotta, 18 ins. long and 3¼ ins. inside diameter. In all some 382,074 lineal ft. of duct were placed.

The number of ducts laid in parallel varied, of course, inversely with the distance from the power house, as can be seen in Fig. 6.

Suitable manholes (Fig. 2) had to be constructed at intervals of about 400 ft. on straight track, and at shorter distances on curved sections. In the construction of these, excavations were made, reaching from track to track, in which board forms were braced. Concrete was then packed into the mold thus formed to form the walls of the manholes, which were made 12 ins. thick. As seen in Fig. 2, beveled wooden blocks were built into the two sides next the tracks. To these will be secured wooden strips to support the insulators for the feeders and tap wires. The manholes are 4 × 4 ft. by 7 ft. in depth, except where, owing to the grade of the street, the conduits drain into the manholes. At such points the depth is increased 18 ins.

Owing to the fact that the cable conduit had to be made large enough for the pulleys used to support the cable, its depth is considerably greater than that of ordinary electric railway conduits. This additional depth, however, facilitates the drainage of the conduit.

Fig. 3 is a section of the slot rail and upper portion of the cable yokes showing the insulator brackets, conductor rails, hand holes, etc. In placing the insulators the process where hand-holes already existed was simple, necessitating only the drilling of two ¾-in. holes in the center of the foot of the slot rail, 6⅞ ins. c. to c. The complete insulator, including cup, porcelain and pin, was then bolted in place, as seen on the right slot rail of Fig. 3. At intermediate points, or where no cable pulley traps existed, the process was as follows: The proper position being marked, the asphalt paving was removed from rail to slot for a width of about 18 ins., and the top of the concrete conduit was cut through. Two holes were then drilled in the foot of the slot rail, as already described, and two in the center of the web. To the former was bolted the insulator, and to the latter, the rim of the hand-hole, as seen in the left-hand part of Fig. 3.

In this way no changes in the track, slot, conduit or switches were necessary, since the cable and the electric conduit switches are practically the same, operating both slot and track tongue at the same time. However, the old track on Pennsylvania Ave., from 17th to 1st streets, a distance of about 1⅓ miles, will be replaced by a 6-in. 87-lb. per yd. rail, as the present rails are considerably worn. This new section will have cast rail joints.

The insulators are the same as those used in all recent construction. They consist of a cast-iron cup (Fig. 3), 5½-ins. in diameter and 5 ins. deep, with a corrugated interior surface and a suitable wing or lug for bolting to the slot rail. In the casing is placed a heavy porcelain cup insulator whose exterior is corrugated to correspond with the casing. In the space left is cast a grout of neat cement, which firmly locks the porcelain in place. The iron pin which supports the offset for the conductor rail is screwed into the porcelain. The offset just mentioned is arranged to fit the insulator stud and to support the conductor rail. Fig. 4 represents the style of offset and conductor rail used on the new construction of the Metropolitan System of New York. The slight change of shape required to meet the conditions in Washington is shown by Figs. 3 and 4.

In New York the distance from the top of the slot rail to the center of the conductor rails is 14 ins., while on the remodeled lines of the Capital Traction Co. it is only 13 ins. The distance between conductor rails in both cases is 6 ins. The distance from center of stud to rubbing face is ⅝-in more in Washington, while the offset has a bend of 9-16 ins. The conductor rail weighs 23½ lbs. per yd., with an area of 2.3 sq. ins., and is made in 30-ft. sections. It has a 4-in. rubbing face, is ⅜-in. thick, and has a 1½ × ⅜-in. rib. The conductor used in New York (Fig. 4), is T-shaped, with a 3-in. face, and weighs 21 lbs. per yd.

As will be seen from the lower part of Fig. 3, two flexible copper bonds are used at the ends of the 30-ft. sections. These have a total section of 423,200 circular mils, and are practically equal in conductivity to the steel conductor rails. The method of supporting and locking these rails is clearly shown by the drawings.

The small angle irons riveted to the under side of the slot-rail are drip pieces, designed to prevent water running down the sides of the conduit. Their placing will require the drilling of some 36,577 holes, 5-16-ins. diameter, in the slot rails, spaced about 4½ ft. apart and the countersinking of these holes to allow flush riveting.

The plow, Fig. 5, in its present form is the result of experience, and is identical with that to be used is New York, except for the manner of support. It consists essentially of three parts; the hanger, or two ⅜-in. steel strip, spaced so as to protect the two conductors; about 12 ins. from front to rear and 18-in. long; the body, which runs in the conduit and contains the springs, flexible conductor, etc., and the contact shoes. These shoes are cast-iron blocks with rounded edges about 4 × 2¾ × ½-ins. They are mounted upon flat springs and normally stand about 8 ins. apart. As the conductor rails are only 6 ins. from face to face, a compression of 2 ins. results, which gives a pressure of about 6 lbs. between shoes and conductor rail. Short flexible conductors connect the blocks with carefully insulated copper ribbons, which run up the hanger, protected by thin steel plates, to the top, where they end in suitable plug connectors.

The method of supporting the plow is novel, and is intended to prevent the delays consequent upon the plow jamming in the slot at switches, turnouts or crossovers. Fig. 5 gives a very clear idea of this. It will be noticed that two slots, ¾ wide by 1¼-ins. deep, are cut in the hanger at the upper end. To a frame, connected to the car through a spring suspension are screwed two cast-iron brackets provided with projections or slides 1½ ins. and 13 ins. long. As will be seen, the plow while anchored in the direction of motion, is free to slide across the track on these bracket slides should, through any cause, the car continue ahead while the plow started around a switch slot, or vice versa. This arrangement would allow the process to continue until the hanger reached the ends of the slides, when the plow would drop off, the plug contacts would pull apart and the car would come to rest without any damage to car, plow or switch.

The old powerhouse site was abandoned in favor of one on the banks of the Chesapeake & Ohio Canal, in Georgetown, D. C., where a brick building, 298 × 62 ft. by 65 ft. high, formerly used as a mill and warehouse was selected. The building will be divided into an engine room, 134½ × 59 ft. 10 ins., and a boiler room, 162 ft. × 59 ft. 10 ins., which will also contain the stack and the coal storage bins. The present floor is 3.13 ft. above the canal level. New floors will be built, making the engine room 16.03 ft. above the canal level, and the boiler room 5.20 ft. above. At the end of the boiler room opposite the engine room will be built a 9-ft. steel chimney, 150 ft. high. In the engine room will be placed five horizontal tandem compound Allis Corliss engines, 20 × 40 × 42 ins., rated at 800 HP., and running condensing, using Deane Condensers. These will be directly connected to 550 K-W. General Electric railway generators, giving at 100 revolutions a pressure of 600 volts. To keep up the pressure on the long feeders running to Mount Pleasant and the Navy-Yard, about 4½ miles distant in the former case and about 5¼ miles in the latter, three General Electric 100 K-W. boosters will be used. These have a full load output of 550 ampere at 180 volts. The boiler room will contain four batteries of Cahall Babcock & Wilcox boilers, fitted with Roney stokers and other labor-saving appliances. Coal will be taken directly from the canal boats to the coal bins overhead by suitable conveying machinery, from which it will be fed directly into the stoker hoppers.

Fig. 6 represents the feeder scheme, which is unlike overhead trolley systems, in that four feeders, two positive and two negative, are run to each of the sections into which the road is divided. In this way the up and down tracks are made independent, and the liability of shut down is decreased. The feeders will all be 1,000,000 circular mils lead incased cables with taps to the conductor rails about every 800 ft.

Since starting the work above described it has been decided to also change the 7th St. line, including about 3 miles of double track, from cable to electric traction, and as soon as possible the cable will be shut down and the work of transformation begun. When this is finished the entire city lines of the Capital Traction Co. will be operated by the conduit electric system. We are indebted to Mr. D. S. Carll, Chief Engineer and Superintendent of the company for the most of the material used in this description, and for the blue prints from which our drawings have been prepared.

THE PROTECTION OF RAILROAD TRAFFIC THROUGH TUNNELS.

By Charles Hansel, M. Am. Soc. C. E.*

The majority of tunnels built in the original construction of railways in the United States are for a single line of track, and on many roads the increase of business, as is well known, has made it necessary to double-track the line and enlarge the

*Vice-President and General Manager, National Switch & Signal Co., 43 Cedar St., New York city.

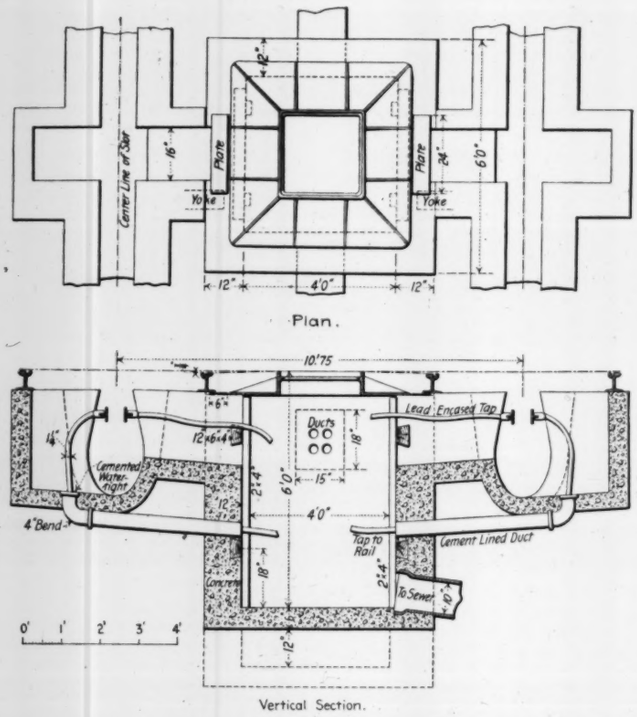


FIG. 2. FEEDER MANHOLE AND SECTION OF TRACK AND CONDUIT.

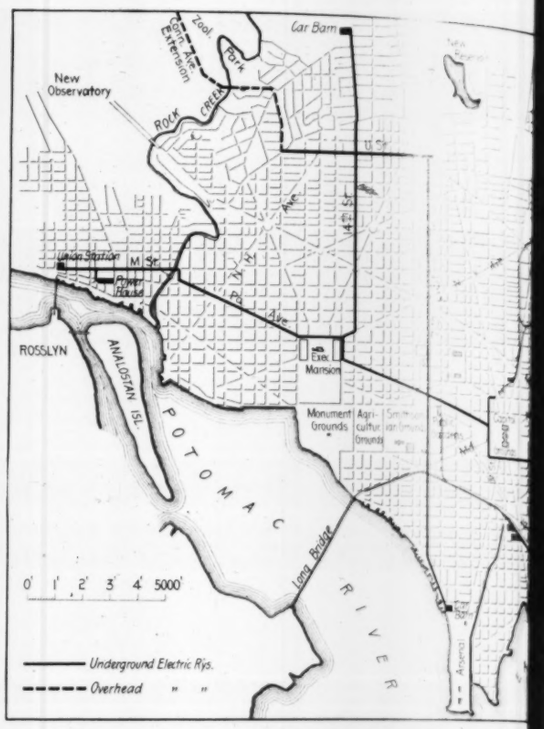


FIG. 1. MAP SHOWING TRACKS OF CAPITAL TRACTION CO., WASHINGTON, D. C.

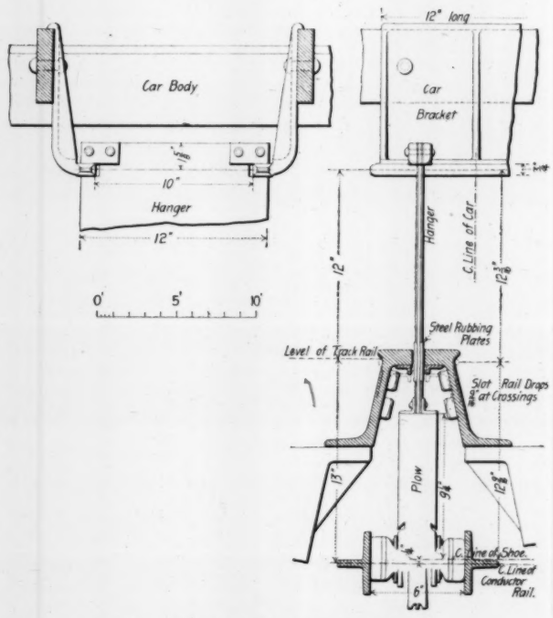


FIG. 5. PLOW AND PLOW HANGER, SHOWING RELATION TO SLOT AND CONDUCTOR RAILS.

CHANGING A CABLE STREET RAILWAY TO A CONDU ELECTRIC SYSTEM.

Capital Traction Co.,
Washington, D. C.

D. S. Carll,
Chief Engineer and Superintendent.

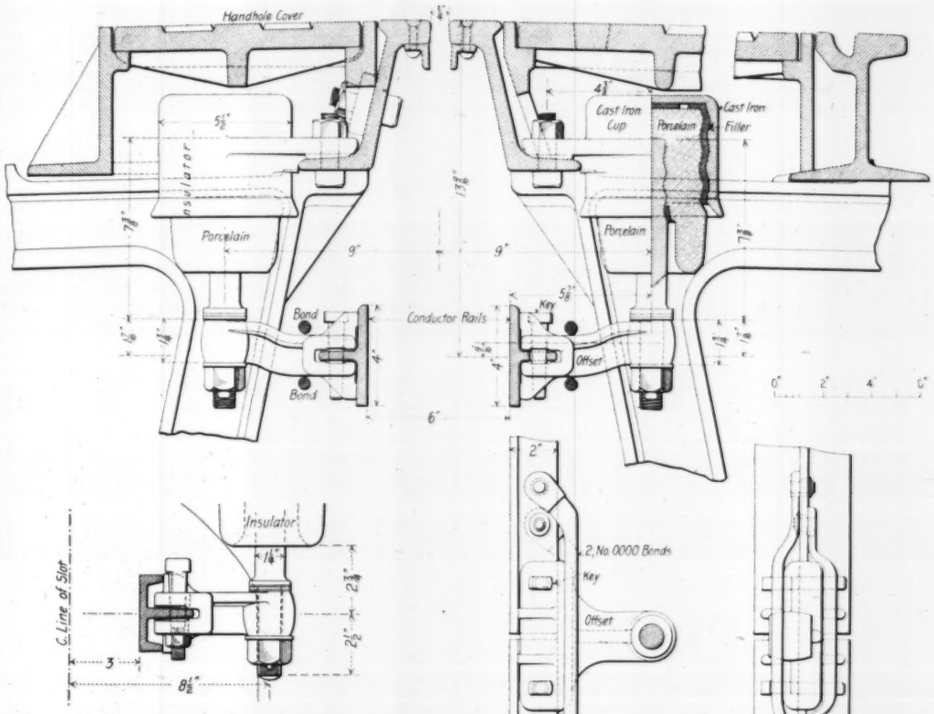


FIG. 4. OFFSET SUPPORT
FOR CONDUCTOR RAIL.
METROPOLITAN ST. RY., NEW YORK CITY.

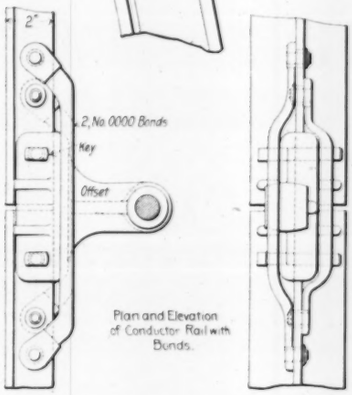


FIG. 3. DETAILS OF UPPER PORTION
OF CONDUIT SHOWING INSULATOR, SLOT RAILS,
CONDUCTORS, BONDING, ETC.

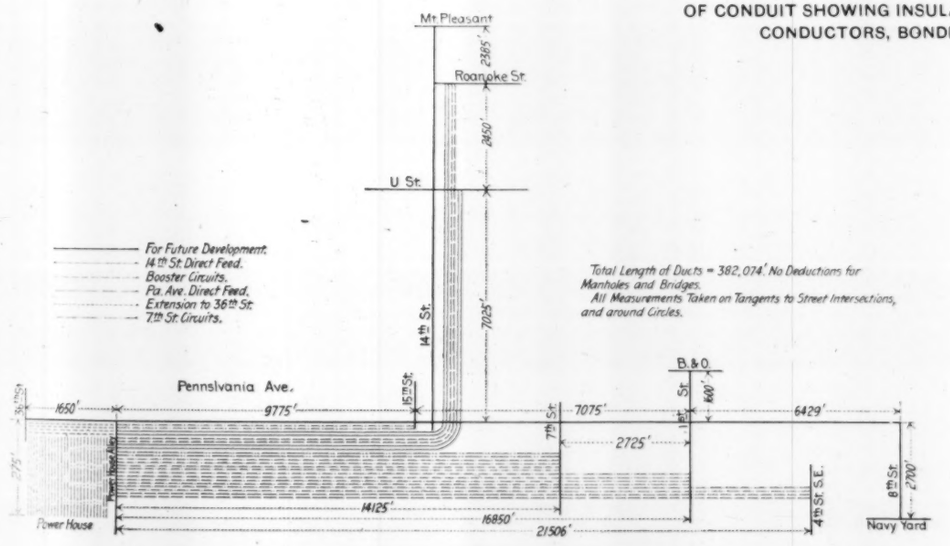
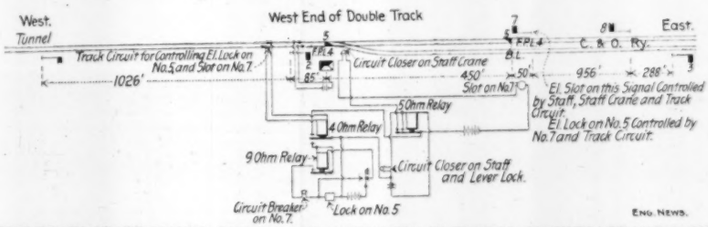


FIG. 6. DIAGRAM OF FEEDERS AND CONDUITS.

tunnels. If it were practical to arrange a system whereby the enlarging of the tunnels would not be necessary, and at the same time maintain the full capacity of the line, it is plain that a vast saving in money would result to the railways. An arrangement which accomplishes this object has been lately installed on the line of the Chesapeake & Ohio Ry., controlling the traffic between the stations of Lowell and Hilldale, Va. Between the two stations is a tunnel 6,500 ft. long, and a bridge 528 ft. long, and the total distance between the stations is 4.2 miles. The tunnel is only large enough for a single track. In order to move traffic through this tunnel on a single track, with perfect safety and without train orders, an absolute block system has been established between Lowell and Hilldale, known as the Electric Train Staff System, with electric locking and electric slots as auxiliaries.

The location of all signals, derails and circuits at Lowell are illustrated in the accompanying cut, and the apparatus at Hilldale exactly duplicates it. The home signals admitting trains to the tunnel are fitted with an electric slot; the derail levers are fitted with electric and staff locks, and there is a train staff pillar in each tower and a staff crane in front of each tower. In the normal position of the machine and train staffs, that is, all staffs being in the staff pillar, the home signals are kept at danger, and the reversing of the lever will not clear them, and it is necessary to complete the circuit and energize the magnets of the electric slot on the home signals in order that the operator may clear them. This cannot be done until a staff is removed from the staff pillar and placed in the crane in position to be taken by the engineman. The removal of a staff either from the Hilldale or Lowell staff pillar prevents the removal of a second staff from the same pillar until the first staff has been carried to the opposite station or


West.
Tunnel
West End of Double Track
East.
C. & O. Ry.
Track Circuit for Controlling El. Lock on No. 5 and Slot on No. 7.
1026'
Circuit Closer on Staff Crane
450'
50'
956'
288'
Slot on No. 7
El. Slot on this Signal Controlled by Staff, Staff Crank and Track Circuit.
El. Lock on No. 5 Controlled by No. 7 and Track Circuit.
5 Ohm Relay
4 Ohm Relay
9 Ohm Relay
Circuit Closer on Staff and Lever Lock.
Circuit Breaker on No. 7.
Lock on No. 5
ENG. NEWS.

ELECTRIC TRAIN STAFF SIGNAL SYSTEM FOR SINGLE TRACK TUNNEL ON CHESAPEAKE & OHIO RY.
Designed and Built by the National Switch & Signal Co., Easton, Pa.

replaced in the pillar from which it was removed, and a staff cannot be taken out of both pillars simultaneously, or as long as there is one staff removed from either. The placing of the staff in the crane is an order for the engineman, and the act of placing it in the crane makes a continuous circuit through the magnets of the electric slot on the home signal, and the operator can now clear his signal. When the engine reaches the tower where the crane is located and the engineman takes the staff as an order to proceed into and through the tunnel, the circuit being again broken, through the slot on home signal, the signal immediately goes to danger and, consequently, we are not dependent upon the act of the signalman to throw it to danger.

Another provision is also made to secure this result. Although in practice experience has shown that the engineman seldom, if ever, misses his staff, it is possible for him to do so and proceed into the tunnel without it, and it is desirable to have the home signal go to danger immediately upon the entrance of the first pair of wheels within the limits of the block. In order to accomplish this a short piece of track circuit has been introduced in advance of the home signal near staff crane, so that the presence of a pair of wheels on this circuit de-energizes the electric slot and the home signal goes to danger the same as if the staff were removed. This slot circuit is also used as the locking circuit, and after the derail has been closed and the home signal given, the operator cannot again open the derail until the train has passed this circuit, thus avoiding the possibility of opening a derail immediately in front of a train moving at high speed. This system of electric locking may be briefly described as follows:

An electric lock is placed on the machine frame in front of the tappet operating with the latch handle of the derail lever. This lock is so designed that when there is no current in the lock magnet the plunger falls by gravity through a hole in the tappet and it is impossible for the operator to raise or lower the tappet so long as the bolt remains in this position. As soon, however, as the magnets are energized, the movement of the armature pulls the bolt free from the tappet and the operator can then change the position of his signal. The normal position of this lock frees the lever, the derail being open. When it is desired to clear the home signal the first act of the operator is to reverse the derail lever, closing the derail and locking it on the ground through the facing point lock. He then reverses the home signal lever, clearing the home signal. The act of reversing this home signal de-energizes the electric lock magnets by shunting the current through a knife switch on the tail lever of the home signal and the bolt plunges through the tappet, as before described, and although the operator may at any time replace the home signal to danger, this act does not renew the current, and the derail remains locked closed until the train has passed over and beyond it, except in case the current is renewed by the hand release, which is furnished for the purpose of enabling the operator to change his signals in case a train does not require the signals after they have been cleared or in case there is any failure in the track circuit. This hand release is in this case a simple switch enclosed in a box having a glass case, the key of this box being in the hands of the signal inspector, and not in the possession of the signal operator, and in case it is absolutely necessary to employ the services of this release switch the operator is compelled to destroy the glass, which action must be reported with explanation of cause.

The purpose of the derail is twofold: That is, to prevent fouling at the end of double track, and also to prevent trains entering the tunnel unless the tunnel is absolutely clear. In order to insure that both derails cannot be closed at the same time, a stiff lock on the derail lever is introduced. When a staff is removed from the pillar it is placed in the staff lock on the derail lever and the lever unlocked and reversed, closing the derail. The staff is then removed from the staff lock and placed in the crane. The derails and switches at opposite end of tunnel remain locked in the normal position, and cannot be unlocked until this train staff is carried through the tunnel to the opposite staff station. This absolutely prevents the engineman from overrunning his signal at either end and proceeding into the tunnel, and consequently all head end collisions are prevented.

The manipulation of traffic between Lowell and Hilldale may be described as follows: We will suppose a train to be approaching Lowell, west bound. The operator, observing its approach, or being advised of the time of its arrival, either by telegraph code or time-table, asks the operator at Hilldale for an unlock to permit him to remove staff. If a train has been given a clear signal at Hilldale to go to Lowell, this unlock cannot be given Lowell, the derail, No. 5, will remain open and signal, No. 7, remain at danger, which will necessitate the stopping of the east-bound train at the home signal, or else if it should not stop it will be derailed and carried on the ties. If, however, there is no train between Hilldale and Lowell, and the operator at Hilldale has not cleared his signal, he will give Lowell an unlock which permits him to remove a train staff. Having withdrawn this staff from the pillar he places it in the staff lock on the derail lever and unlocks the derail lever, No. 5. This lever also being connected with the switch No. 5, by reversing it he sets the switch for a west-bound movement, and closes the derail, and the opposing derail and switch at Hilldale remain locked in the normal position. He then removes the staff from the staff lock and places it in the crane outside of his cabin, which act energizes the magnets on the electric slot on home signal No. 7. He then reverses home signal lever No. 7 and the west-bound train proceeds under a clear signal. The entrance of a pair of wheels into the block section beyond the derail No. 5, or the removal of the staff from the crane, de-energizes the magnets of the electric slot on the home signal No. 7, which immediately goes to danger. The engineman now proceeds through the tunnel, having absolute protection in front by the fact that the home signal at Hilldale is at danger and the derail open and protection in the rear through the home signal No. 7 being at danger, and as soon as the rear end of his train has passed the short track circuit beyond the switch the operator can open his derail so that the train is then moving on a single track protected by an open derail in front and rear on the lines which might otherwise admit opposing traffic. Since the signalmen at Lowell and Hilldale cannot remove a second staff so long as the first one issued remains out of either pillar, they cannot give orders for an opposing train to enter the block or follow the first train into the section, and in consequence the engineman on this west-bound train, as described, absolutely controls the movement of traffic over the section between the home signals at Lowell and Hilldale until he has reached Hilldale and delivered this staff to the signalman at that point.

No diminution of speed is required in picking up the staff. In daily practice it is picked up at a speed of from 30 to 40 miles per hour without the means of any automatic mechanism, but simply by the hand of the engineman. If it is found impracticable to take the staff at a speed greater than this, and such speed is desired, the apparatus described very fully in the catalogue and pamphlets of the National Switch & Signal Company of Easton, Pa., provides for this requirement. No derails or signals are provided for a backup movement, and if such a movement is made it would be necessary to make this provision, which is simply an extension of the system hereinbefore described. A reverse movement, that is, from Hilldale to Lowell, would be made in the same manner as hereinbefore described for the movement from Lowell to Hilldale.

This block system was designed and furnished by the National Switch & Signal Co., of Easton, Pa., and the whole plant was installed under the direction of F. W. Scarborough, Assistant Engineer Maintenance of Way, Chesapeake & Ohio Ry., Hinton, W. Va. The staff instruments had been in operation at that point for some time before the auxiliary electric locks, slots and derails were added, and since the installation of this work the plant has met with such approval by the officials of the Chesapeake & Ohio that they have decided to add electric locking, electric slots and derails at other points where they now are operating with the train staff only. We believe this is the most complete and valuable system of block signaling for the protection of single lines through a tunnel, which single line is required to carry all the traffic delivered to it from a double track on each side of the tunnel, and we are assured by the operating officials that they are able to handle traffic not only with absolute safety, but with as great facility as if they had gone to the great expense of enlarging this tunnel to accommodate a second track.

CHARCOAL-MAKING FROM PEAT has been patented by a Mr. Blundell, of England, and a company is exploiting it on a large scale in Italy. The peat is first reduced to a fine paste and leaves the machine in a continuous thick tube, 3 to 5 ins. diameter, and is then cut off in sticks and dried for three days on wooden supports, and for a longer period in the air on wire netting. After 25 days the sticks become dry and hard and may be burned as fuel; but it is more profitable to convert these sticks into charcoal. This is accomplished in six hours in a retort, and three tons of peat in a retort make one ton of charcoal. Italy uses about 700,000 tons of charcoal per year; and this peat charcoal can be sold at a handsome profit, as it costs at the retort about $5 per ton, and wood charcoal costs from $16 to $20 per ton. Italy has an inexhaustible supply of peat.

A SEWAGE PUMPING ENGINE AT CHARLOTTENBURG, GERMANY.

We reproduce herewith from the "Zeitschrift des Vereines Deutscher Ingenieure" a plan and sectional elevation of a sewage pumping engine completed last year for Charlottenburg, Germany, which presents several novel features. The chief of these is the Riedler system of positive moved valves for the water end. As many of our readers are aware, this system has come into widespread use in Germany, and to some extent in this country and its advantages for economical working are fully proved.

As seen by the drawing, the engine is a duplex cross-compound. The pump plungers are single acting. The positive moved valves are on the outer end and control the ports on the pressure side of the plunger. These valves are worked from a wrist-plate which derives its motion from the steam valve gear. The suction valves are flap valves of a peculiar form. The hinge is connected with the flap by strong but elastic rubber plates which insure the prompt closing of the valve at the end of the stroke and without shock.

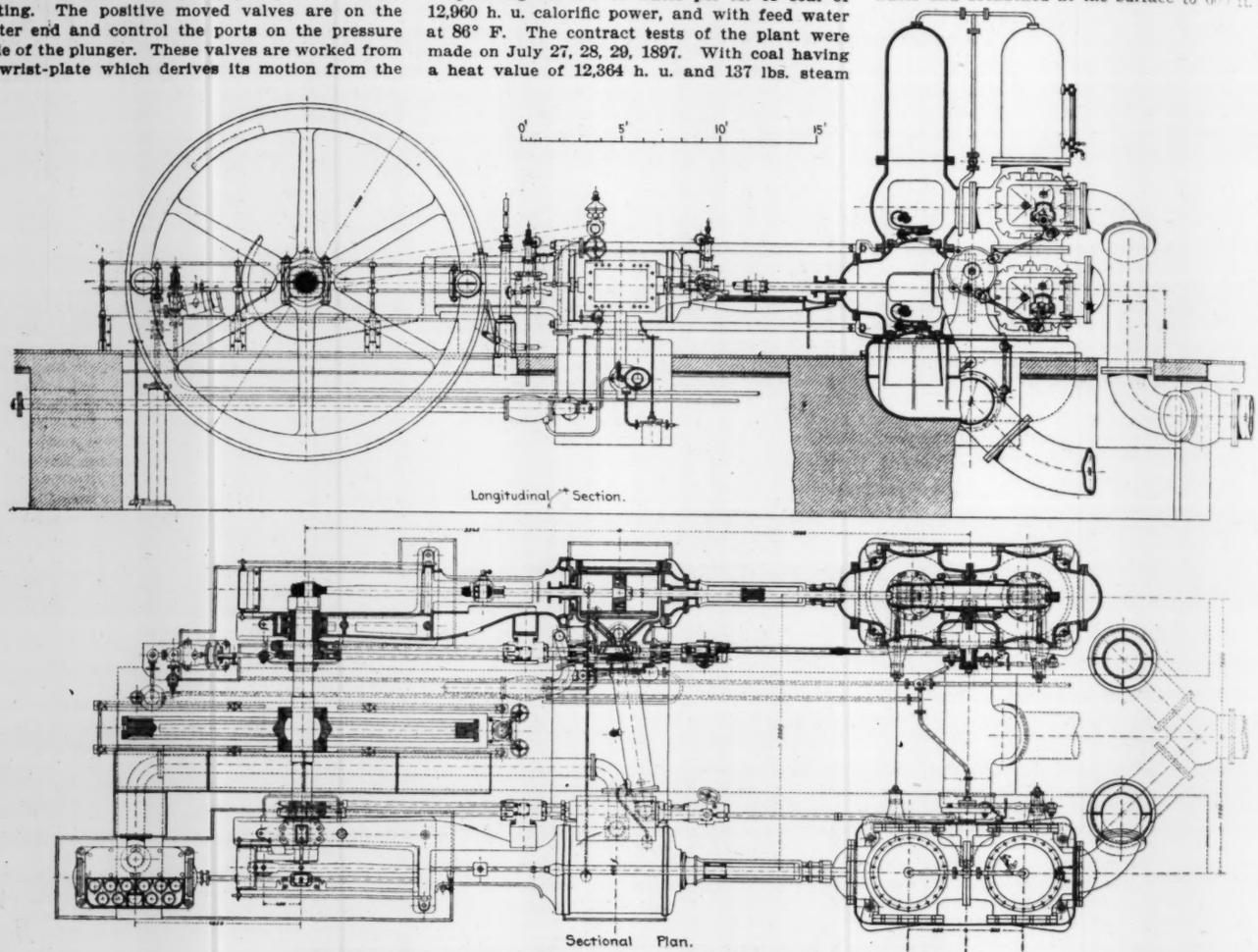
The plunger is of the central-packed type, and a device has been adopted to reduce its wear and the frequency of repacking, which is especially noteworthy. As seen by the drawing, the packing about the plunger is double and a chamber is left about the center of the plunger. This chamber is filled with oil, which is kept under pressure by a small pump. The plunger is thus kept perfectly lubricated, is to a certain extent protected from corrosion by the acids in the sewage, and from injury by sand and grit getting between the plunger and the white metal lining. It appears to us that this design is well worth attention by American builders of sewage pumping machinery, and engineers who draw specifications for it.

Another interesting detail of this machine is a small air pump, which is operated by a rod from the high pressure eccentric. This pump is connected to a system of piping which enables it to draw, or force air into the air chambers on the suction and force mains as desired.

The steam end of the pump has a valve motion of the Meyer type, with adjustable cutoff. A governor is attached, but its only office is to keep the speed below certain limits.

The steam cylinders are 16.7 ins. and 25.6 ins. in diameter and the plungers are 12.4 ins. The stroke is 31½ ins. The machine was built by the Berlin Aktien-Gesellschaft fur Eisengieserei und Maschinen-fabrikation of J. C. Freund & Co., of Charlottenburg, which was the lowest bidder for the work and which guaranteed an economy of 2.8 lbs. lbs. of coal per HP. hour, with the boilers evaporating 8.2 lbs. of water per lb. of coal of 12,960 h. u. calorific power, and with feed water at 86° F. The contract tests of the plant were made on July 27, 28, 29, 1897. With coal having a heat value of 12,364 h. u. and 137 lbs. steam pressure the consumption of steam was as follows:

	Engine No. III.	Engine No. IV.
Lift, ft.	108	107
Horse-power	84.2	84
Lbs. steam per HP. hour	21.5	21.4
Lbs. coal per HP. hour	2.48	2.42



SEWAGE PUMPING ENGINE WITH RIEDLER VALVES AT CHARLOTTENBURG, GERMANY.
Built by the Berliner Aktien-Gesellschaft fuer Eisengiesserei und Maschinenfabrikation.

THE PROPOSED IMPROVEMENT OF THE MOUTH OF THE MISSISSIPPI.

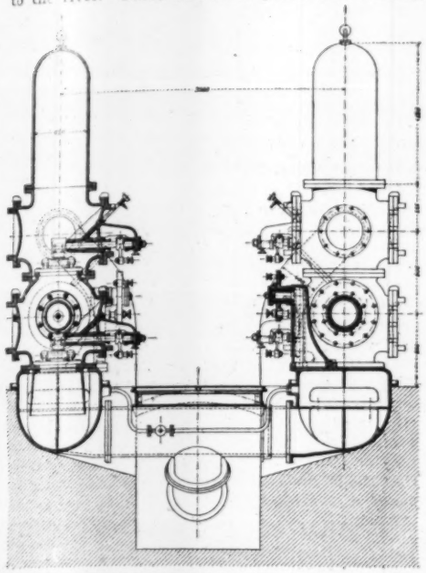
The committee of U. S. Senators, appointed to investigate and report upon the improvement of the Mississippi River and its mouth, has finished its personal inspection from Cairo to the Delta. From the New Orleans "Daily Picayune" the following abstract is made of the arguments submitted in connection with a proposed deeper channel at the entrance of the river:

The Senators, officers of the Army and others interested in the project, personally inspected the Southwest Pass; and returning through the South Pass, the party examined the Pass a Loutre crevasse and the work being done to close it. On the way to New Orleans, testimony was taken, and Major J. B. Quinn, Engineer Corps, U. S. A., and in charge at the jetties, was the first witness. He explained the conditions at South Pass, and said that when the work at the pass was commenced the heaviest draft was 25 ft., and the contract called for a navigable depth of 26 ft.; and the present law calls for a channel 300 ft. wide and a navigable depth of 26 ft. The character of the channel at the head of the pass has been very good; but that of the general channel has varied; in places the depth has been as low as 24 ft., and probably 23 ft. for a short time. But the average has been 26 ft. Major Quinn believed this South Pass channel could be deepened to 30 ft. at low water and broadened at the surface to 600 ft. for about $3,000,000, and $150,000 per year for maintenance.

Major Quinn was not very hopeful about improving the Southwest Pass. He said that 5 miles of jetties would be required at both ends of the pass, and he doubted if 32 ft. at low water could ever be secured over the bar in this pass. He recommended, however, a complete investigation of this subject by proper surveys. In answer to questions Major Quinn made the startling announcement that he did not look upon the jetties at the South Pass as a success; but he modified this statement by saying that he did not consider any work of this character a success which would not last for 100 years. The jetties had increased the depth over the original bar from 9 to 26 ft.; but he claimed that the river was constantly depositing silt outside the mouth of the jetties, and this action would continually require their elongation, until a point would be finally reached, where the scouring action would cease from lack of the necessary hydraulic head. If the jetties were built 3 miles further out into the Gulf, at a cost of about $20,000,000, permanent deep water could be reached.

The next witness was Mr. Donovan, the engineer in local charge of the jetties for the last 21 years. His testimony was diametrically opposed to that of Major Quinn, concerning the Southwest Pass. He believed that a channel of 36 ft. could and should be obtained there. He also claimed that the work had not been properly kept up on the South Pass, and that its shoaling was largely due to the failure to replace all of the 3,000 lin. ft. of training wall carried away, and to keep up the dam at the head of the pass, intended to divert water from Pass a Loutre into South Pass.

Mr. W. P. Ross, of the New Orleans Executive Committee on Deep Water, gave the commercial reasons for deepening and widening the entrance to the river. Other American ports were seeking



End View and Cross Section Through Pump End of Charlottenburg Sewage Pumping Engine.

35 ft. of water, and English steamers were being built over 600 ft. long and more than 80 ft. beam, and these conditions demanded corresponding improvement on the plans of 25 years ago. He also noted the direct loss to ship-owners—or rather to the producers who really paid the bills—due to shoaling and detention. The usual method of reckoning detention is 8 cts. per ton register per day: and a vessel carrying 27,000 bales of cotton is figured at 4,755 tons net, and represents a detention loss of about $400 per day. Towage expenses resulting from running aground may amount to from $500 to $10,000, as the service charge of the towboats ranges from $20 to $30 per hour. For the reasons given Mr. Ross contended that the South Pass channel was too narrow for the present long ships; 700 ft. was the least useful width with a 30-ft. channel. Mr. Ross favored the improvement of the Southwest Pass, with a channel 35 ft. deep at low water and 800 to 1,000 ft. wide at the bottom at all stages of water. The South Pass channel is 12 miles long from the head of the pass to the sea-end of the jetties, and it is about 600 ft. wide at the surface and 200 ft. wide at the bottom with an average depth of 26 ft. The Southwest Pass channel would be about 15 miles long, between the head and deep water, but it is 1,500 ft. wide throughout, and is generally from 40 to 50 ft. deep and 800 ft. wide on the bottom. The real work required would be at the head and the sea-end of the pass. Mr. Ross did not believe that the South Pass could be economically or safely enlarged to the dimensions demanded by modern commerce.

Major B. M. Harrod, late President of the American Society of Civil Engineers, in testifying favored the improvement of the Southwest Pass. He said that to enlarge the 26-ft. dimensions of the South Pass to those proposed would mean the removal of 20,000,000 cu. yds. of material; and to do this by scowing was about as possible as it was "to bore a 4-in. hole through a 3-in. plank." He believed the improvement of the Southwest Pass was absolutely practicable and would alone meet the demands of commerce.

THE FOREIGN COMMERCE OF THE UNITED STATES IN 1897.

The Bureau of Statistics has just issued its summaries of imports and exports for 1897, and the figures furnish a valuable index of the relative commercial status of the principal seaboard cities. The accompanying table gives a summary of the imports and exports by customs districts for all ports where the volume of either incoming or outgoing business in 1897 was in excess of $400,000:

IMPORTS BY CUSTOMS DISTRICTS.

Districts.	1895	1896	1897
Atlantic Ports—			
Baltimore, Md	$14,009,531	$10,326,485	$11,128,473
Bangor, Me	1,078,287	1,170,342	902,410
Boston and Charlestown, Mass	79,947,777	65,990,896	85,688,149
Charleston, S C	510,193	646,584	1,255,483
Hartford, Conn	456,064	387,117	616,774
Newark, N. J	96,987	159,488	430,370
N. Bedford, Mass	55,737	72,049	470,116
Newport News, Va	1,420,714	823,002	1,286,614
New York, N. Y	516,286,774	440,471,795	466,536,700
Passamaq'dy, Me	634,222	570,457	425,153
Philadelphia, Pa	47,271,435	39,807,278	43,646,026
Portland, Me	487,015	515,325	406,812
Providence, R. I	1,136,207	819,376	914,104
Savannah, Ga	273,305	349,237	448,644
Gulf Ports—			
Corp. Christi, Tex	899,243	883,173	967,904
Galveston, Tex	387,347	795,018	644,367
Key West, Fla	555,466	713,901	588,447
Mobile, Ala	1,037,536	860,411	956,712
N. Orleans, La	15,185,356	13,190,771	14,261,555
Paso del Norte, Tex.	1,203,815	1,215,246	1,611,791
Pensacola, Fla	57,957	161,610	546,911
Saluria, Tex	718,924	570,919	718,900
Tampa, Fla	993,680	1,179,392	755,316
Pacific Ports—			
Arizona	502,905	474,202	843,248
Los Angeles, Cal	647,207	646,762	467,270
Puget Sound, Wash	5,318,126	3,716,729	7,705,000
S. Prisco, Cal	38,930,888	36,393,105	40,847,564
Willamette, Ore	824,075	1,118,209	1,478,684
Northern Border and Lake Ports—			
Buffalo Cr., N. Y	3,870,985	3,312,291	4,400,149
Champlain, N. Y	4,787,848	4,944,200	4,007,271
Chicago, Ill	17,187,778	12,117,115	10,078,929
Cuyahoga, Ohio	1,904,964	1,498,371	1,426,365
Detroit, Mich	3,459,202	3,153,609	2,708,833
Duluth, Minn	1,349,160	1,154,567	2,168,781
Huron, Mich	2,881,677	2,500,503	2,750,298
Memphremagog, Vt	.....	.....	486,427
Milwaukee, Wis	917,554	613,663	536,386
Minnesota, Min	1,568,817	1,066,406	714,061
Niagara, N. Y	2,948,934	2,545,140	2,740,514
N. & S. Dakota	495,893	479,998	692,750
Oswegatchie, N. Y	6,792,627	4,629,911	6,032,951
Oswego, N. Y	836,417	798,270	813,746
Vermont, Vt	7,551,196	5,999,437	5,279,296

EXPORTS BY CUSTOMS DISTRICTS.

Districts.	1895	1896	1897
Atlantic Ports—			
Baltimore, Md	$60,180,097	$81,541,341	$98,609,683
Bangor, Me	1,232,417	1,538,780	1,428,920
Beaufort, S. C	4,162,619	4,316,250	2,605,896
Boston and Charlestown, Mass	89,019,873	101,466,212	104,191,600
Brunswick, Ga	4,904,094	6,188,860	8,693,222
Charleston, S. C	9,838,457	11,149,168	10,794,000
Delaware	4,213,223	4,912,902	4,363,277
Fernandina, Fla	1,468,067	1,280,682	1,907,172
Newark, N. J	707,277	624,855	763,118
Newport News, Va	13,586,730	18,150,037	25,924,908
New York, N. Y	332,350,321	375,021,644	404,750,496
Norfolk and Portsmouth, Va	6,509,158	15,271,995	15,399,456
Perth Amboy, N. J	66,614	727,306	973,871
Philadelphia, Pa	36,833,786	42,776,884	51,802,963
Portland and Falmouth, Me	2,046,385	4,258,268	4,623,480
Savannah, Ga	21,690,283	22,680,811	26,406,033
Wilmington, N. C	5,943,007	8,632,287	8,357,447
Gulf Ports—			
Corpus Christi, Tex	3,481,644	5,220,607	4,372,821
Galveston, Tex	36,182,388	56,027,431	60,968,589
Key West, Fla	1,033,399	615,913	705,320
Mobile, Ala	6,224,387	9,087,076	8,140,502
New Orleans, La	71,327,601	95,806,479	99,890,819
Paso del Norte, Tex.	3,268,459	4,824,385	5,514,968
Pearl River, Mass	1,061,528	1,461,127	1,744,300
Pensacola, Fla	3,196,609	6,309,096	8,436,679
Saluria, Tex	1,544,434	1,705,766	1,433,745
Tampa, Fla	1,004,370	769,193	820,792
Pacific Ports—			
Arizona	867,526	1,031,317	949,695
Puget Sound, Wash	5,728,125	10,549,137	14,561,743
San Diego, Cal	168,065	204,453	444,097
San Francisco, Cal	29,195,150	39,786,024	39,803,451
Willamette, Ore	5,444,892	6,972,428	8,372,080
Northern Border and Lake Ports—			
Buffalo Creek, N. Y	4,528,988	4,741,993	5,996,421
Champlain, N. Y	3,925,557	4,516,320	5,294,947
Chicago, Ill	1,145,456	2,509,124	3,327,981
Cuyahoga, Ohio	949,332	1,498,995	1,493,116
Detroit, Mich	3,557,445	11,325,807	11,476,234
Duluth, Minn	3,420,113	3,904,551	4,333,092
Genessee, N. Y	693,300	793,887	729,808
Huron, Mich	6,821,971	7,036,087	6,847,068
Memphremagog, Vt	.....	.....	607,650
Miami, Ohio	965,485	645,654	1,000,944
Niagara, N. Y	6,274,130	5,592,165	6,644,595
N. and S. Dakota	1,512,872	1,806,405	2,794,073
Oswegatchie, N. Y	2,358,419	3,252,101	4,860,855
Oswego, N. Y	1,683,912	1,800,025	1,891,102
Superior, Mich	5,216,290	4,708,302	3,715,007
Vermont, Vt	7,959,577	8,652,767	8,585,650

THE PORT ARTHUR CANAL SCHEME is tied up in prospective extensive litigation, says the Kansas City "Journal," by an injunction granted by the U. S. Circuit Court. The charter of the Port Arthur Channel & Dock Co. calls for the construction of a ship canal, 9 miles long, extending from deep water at or near Sabine Pass, on the Gulf, across and through Sabine Lake, to Port Arthur, Texas. The company is incorporated under a civil statute authorizing the construction of ship channels through the shallow lakes and bays along the Texan coast. Dredging was commenced in Sabine Lake, but was stopped by the government for lack of federal authority. An effort was then made to dig the canal by land; and the company sought to condemn a right of way through the lands of Latham Davis, of Omaha, Neb. The company's action was sustained by the local court; but the plaintiff, as a non-resident, had the case transferred to the United States Court, with the above result, and work is stopped. Davis also claims that the charter of the company is for a channel in the lake and not through his land. The land in litigation is on Mesquite Point, extending out into Sabine Lake; and in this land the Sabine Land & Improvement Co. is interested, as the proposed canal would cut off and render practically valueless several hundred acres of land. This land company and the Kansas City, Pittsburg & Gulf Ry. are nominally opposed to the proposed canal, as a possible silt carrier and an injury to the existing harbor and jetties. Sabine Lake is now a settling basin for this silt.

WEATHER TABLE FOR JANUARY, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—rain or melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt	13.1	56	−22	78	—	36	SW	3.30	0.86	15
	Portland, Me	21.4	45	−6	51	7.5	36	NE	6.61	1.28	13
	New York City	32.2	55	5	50	13.6	61	W	3.95	1.43	15
	Pittsburg, Pa	35.3	67	10	57	8.3	36	SW	3.40	0.67	18
	Chicago, Ill	28.6	55	6	49	17.8	66	NE	3.54	1.13	11
	Omaha, Neb	28.3	45	8	37	6.5	24	N	0.62	0.21	7
	St. Paul, Minn	22.6	43	−2	45	7.1	30	NW	0.04	0.03	2
	Duluth, Minn	19.0	38	−6	44	—	36	W	0.38	0.17	6
	Bismarck, N. Dak	17.8	46	−10	56	7.3	40	NW	0.20	0.16	4
	Average	24.3	50	−2	52	9.7	41		2.45	0.66	10
Southern Cities.	Washington, D. C	36.6	63	17	46	7.6	38	NW	3.54	1.02	15
	Louisville, Ky	40.0	70	15	55	10.9	53	W	9.04	2.55	13
	St Louis, Mo	37.3	63	10	53	11.2	66	SW	4.53	1.28	11
	Savannah, Ga	55.5	79	23	56	9.1	30	NW	0.36	0.14	8
	Kansas City, Mo	32.4	58	12	46	7.0	33	S	4.12	1.50	10
	Jacksonville, Fla	59.2	81	24	57	7.0	24	SE	0.43	0.20	7
	Chattanooga, Tenn	45.8	75	19	56	8.9	58	SW	5.38	1.68	17
	New Orleans, La	58.6	78	30	48	—	30	NE	1.71	0.61	15
	Memphis, Tenn	46.7	70	18	52	11.6	52	W	10.72	2.65	11
	Palestine, Tex	52.2	76	25	51	8.1	28	SW	5.70	2.11	12
	Average	46.4	71	19	52	9.0	41		4.55	1.37	12
Western Cities.	Helena, Mont	23.3	41	−1	42	6.5	34	SW	0.20	0.10	5
	Port Angeles, Wash	38.6	49	26	23	5.3	30	W	2.39	0.63	15
	San Francisco, Cal	46.7	59	36	23	7.6	32	NW	1.12	0.33	8
	Salt Lake City, Utah	20.6	48	−3	51	4.3	22	NW	0.58	0.17	9
	Santa Fe, N. Mex	24.9	48	−6	54	5.8	27	SW	0.97	0.27	11
	Denver, Colo	29.2	63	−3	66	7.2	36	NW	0.20	0.15	2
	Yuma, Ariz	49.8	76	26	50	—	36	N	0.42	0.16	4
	Average	33.3	55	11	44	6.1	31		0.84	0.26	8

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Is the last iron drawn from a cupola harder or softer than the first iron of the same heat? This is a question discussed by Mr. E. W. Smith in a paper of which we give an abstract in another column. His answer is that it may be either harder or softer, according to conditions, and he gives eight different causes of a mechanical nature, relating to the method of charging, of blowing, of drying the cupola, of varying the distribution of the fuel between the bed and the upper parts of the charge, of drawing off the slag, etc., which may change the conditions of melting and tend to make the iron either softer or harder.

Many of the changes of condition discussed by Mr. Smith seem to be unavoidable incidents of cupola melting. While much may be done, in the way of careful superintendence, to render uniform the conditions of melting, and to increase the chances of obtaining a uniform product, still it seems to us that the cupola must always be considered as an imperfect and unscientific instrument for melting cast-iron, something which must be endured, so long as it is the cheapest instrument available, but which must ultimately give way to better appliances.

The "air-furnace," or reverberatory furnace, has long been used instead of the cupola, for melting cast-iron for purposes in which the highest strength and uniformity are more important than cost of melting, such as the manufacture of cast-iron guns, chilled rolls, etc.; but the cost of installation and operation of such a furnace has been too great to permit its general use. There is, however, another method of obtaining melted cast-iron of uniform quality, and of any desired quality, which is as good as the air furnace, and cheaper than the cupola, its only objection being the cost of installation. It is the method which is used in the most modern Bessemer steel works for obtaining melted iron for the converter. It consists in taking the iron directly from the blast furnace into a ladle, dumping it into an immense "mixer" holding 100 tons or more, from which, when thoroughly mixed and of uniform quality, it is taken by ladles to the converters to be made into steel. The same method is used in the foundries attached to the steel works in which the great ingot molds for casting the steel are made. Iron is taken from the mixer into the foundry, and the cupola is dispensed with. Some day some blast furnace company will build a great iron four dry alongside of its furnaces, with mixers between the furnaces and the foundry, in which the metal can be chemically treated to desiliconize it or to add manganese. Gas-heated ladles will be used, in which small batches of the liquid metal may be treated for special purposes, and either hard or soft castings, or castings of any required degree of strength may be obtained, with a degree of uniformity which is not possible with the cupola process. When that day comes, there will be a revolution in the foundry business as complete as that which during the past ten years has overtaken the owners of the small old-style blast furnaces.

The conversion of a cable street railway into a conduit electric system, which is described elsewhere in this issue, furnishes another bit of evidence as to the trend of affairs in street railway practice which we commented upon in this column three weeks ago. It certainly seems to be the case that the days of the cable as a propelling power for street cars are numbered. No new cable lines are being built, and the Capitol Traction Co. is one of the many cable lines which are discarding the cable in favor of electricity.

The advantages of the electric conduit over the cable are numerous. It is cheaper, both in first cost and in cost of operation. It can be put in place in the street in less time and with far less interference with street traffic. Its liability to accident and delay is less, both in the power house and on the line, and the flexibility of the electric system and the opportunity to draw upon neighboring power stations in case of accident, are advantages which practical railway managers are not slow to appreciate.

It is unfortunate that at present three-phase motors and their controlling apparatus are not developed sufficiently to meet the exacting requirements of city street car service, else we could transform at once from the expensive and cumbersome cable to an ideal system. However, the electric conduit system is so designed that when three-phase motors and controllers shall be perfected to compete with the modern direct current street railway motor the change to three-phase current distribution will be easy. The present low-tension generators with the network of hungry feeders eating up interest and current will be discarded, and in their place street railways will be operated from large central stations, located where coal, water and land are cheapest, and containing high tension three-phase generators from which current will be sent out at high potential to transformers, distributed along the tracks. These will reduce the pressure to a point at which it can be safely distributed and used on the motors. No alterations would be required beyond bonding the track, or at most inserting a third conductor rail in the present conduit.

The absurdity of stipulating that the water rates to be charged by a private company shall be governed by the average of the rates charged in other cities is well shown by a suit between the city of Denver and the Denver Union Water Co., which, after a four months' trial, has just been decided in the local court. If it has taken four months to determine the average of the rates charged in Chicago, Cincinnati and St. Louis, the cities named in the Denver contract, how long would it take to ascertain the average of the rates charged "in cities of the United States having efficient water-works operated by private companies," as was provided in the Des Moines, Ia., water contract? In the Des Moines case this provision was finally dropped as being absurd, and the case was tried on the question of the reasonableness of the rates. This is the only proper standard, as any one familiar with water-works construction and operation can see.

Generally speaking, provisions for regulating rates in accordance with the average rates in other cities specified are intended to blind the real issue or to leave the rates indefinite and indeterminable. The city officials responsible for the Denver contract, for instance, assuming that they gave the matter any especial thought, or were not aware of the farce they were acting, seems to have reasoned thus: If we can get water from a private company at as low prices as the averages paid in Cincinnati, Chicago and St. Louis, where the cities own the works, certainly we should be satisfied. It does not seem to have occurred to these officials that the selling price of water in Denver should be governed by the cost of securing and delivering it, and that local conditions have so great an effect upon the cost of water that a fair rate in one community might be altogether too high in another or unreasonably low in still another. Nor did either party see, assuming both to have been well-intentioned, that equity demands a division of the total cost of water service between the public and private users of water, in proportion to the benefits each class receives. Therefore, if some or all of these three cities were to collect an undue proportion of their water revenue from the general public, in the form of taxes, the average rate would be too low, the public revenue received by the Denver company being fixed. On the other hand, if some or all of the three cities were collecting too great a share, or, perhaps, the whole, of their water revenue from private consumers, the people of Denver would have to pay excessive water rates.

To what extent the Denver rates just established by the court approximate to fairness, we make no pretence of knowing. If they are fair it is not due to the merit of the system followed in establishing them.

The decision is generally considered as a victory for the company, since it is estimated that the rates may be so raised as to increase its total revenue from private consumers by some 6 or 8 per cent. But when the agitation leading up to this suit was begun, the company made a uniform reduction of 20 per cent. in its rates, instead of trying to arrive at the average stipulated in the contract. The city urged that if the average had been found and adopted the reduction would have been much greater. The court, in finding the average, shows that the 20 per cent. reduction was more for some services and less for others, but on the whole greater than the contract required. The contract provision for the average rate, therefore, has resulted in a material reduction in the prices to be paid for water, but neither party has any assurance that the rates as now fixed are equitable.

To what extent can the decision be considered as permanent? The Judge says in his decision that the rates in all the three cities entering into the average have been changed since the controversy began in 1895, and that the Cincinnati rates have been altered during the four months covered by the suit. Each of the three cities is making extensive improvements to its works. All of them may find it necessary to raise their rates. Will the Denver Union Water Co. then be entitled to an advance? Or if, for any reason, the three cities see fit to materially reduce their rates, will the people of Denver be entitled to a like reduction? If the average named was a proper criterion for the cost of water to private consumers in Denver in 1895, as the contract provided, and this still holds true in 1898, as the court has decided, ought not the Denver rates, in fairness, to vary with the average through the balance of the contract.

Some of the rulings made by the Judge are of interest. He holds that where each of three cities does not have a rate comparable with a given item in the Denver schedule the original Denver rate shall stand, because an average here means one-third the sum of the price charged in each of the three cities. He defines service, in the expression charges "for the same service," as meaning a like quantity of water delivered under the same conditions, rather than the mere plumbing fixture, as a hose, through which water is delivered.

In making up his averages the Judge ruled out certain items of free water, as the first bath tub free in Chicago, and water furnished free to school houses in Chicago and Cincinnati, alleging in effect that such conditions were incident to and only possible under municipal ownership. But if water is furnished free to one class of consumers the actual cost of this water must be included in the remaining rates. In other words, Denver not only gets no benefit of the fact that the first bath tub in Chicago and the schools in both Chicago and Cincinnati are supplied free, but the other items in its schedule may be increased thereby if the cost

of this service is put upon the other private services, instead of met in the general tax levy, a point that the decision does not take into consideration.

To sum up what has been said: Cost of service and not the average prices paid in other cities is the only fair basis for fixing water rates. Even though averages of rates charged elsewhere were a proper standard, it is well nigh impossible to establish them legally, even where only three cities are involved, and absolutely impracticable to do so when a large number of cities must be considered.

It may interest some to know that although the contract made in 1890 provided that the water company must reduce its rates in 1895 to conform with the average named if the city authorities so demanded, the people of Denver were compelled to get a mandatory order from the court before the authorities would act in the matter, and to again appeal to the court to determine whether the reduction made complied with the contract. It may also interest some to know that the agitation for lower water rates in Denver has followed close upon a consolidation of two rival companies which for many months conducted a bitter rate war in Denver. This attempt at competition in a natural monopoly resulted as scores of others have, in consolidation, with the further result that the rates were immediately afterwards advanced to the highest point the contract with the city would permit, and kept there, until they were forced down. The court still has before it, in the case under review, questions of purity and pressure, the city claiming that the company has been derelict in these respects.

The incident should enforce upon municipalities and water companies the necessity of using more care and common sense in drafting water contracts. In the long run both parties are likely to suffer if the highest grade of integrity and intelligence be not exercised in drafting the original contract agreements.

Our attention has been called to an error, in our issue of Dec. 16, 1897, p. 386, in the article of Mr. Corthell, on the Cornhouse bridge at Berne, Switzerland. In referring to an excellent work recently published on American bridges, the name and address of the author should have read "Mr. Louis Le Rond, Ingenieur Ponts et Chaussees, 34 Boulevard du 'Contrescarpe, Paris, France."

SEWAGE DISPOSAL AND STREAM POLLUTION IN THE LOWER PASSAIC VALLEY, NEW JERSEY.

A notable river pollution suit has been brought against the city of Paterson by riparian owners along the Passaic River, and also by parties acting on behalf of Jersey City. The plaintiffs ask that Paterson shall cease discharging its sewage into the Passaic River. Among the private plaintiffs, one urges that the pollution thus caused has ruined a profitable ice business formerly conducted by him, and all of them maintain that the river has been made unfit for household use, bathing and stock watering, and, in addition, that it is offensive to sight and smell and dangerous to health. On behalf of Jersey City it is urged that the sewage of Paterson has polluted its water supply, caused the loss of adjoining municipalities as customers for its water, and has finally compelled it to look elsewhere for a water supply, whereas had not the pollution arisen, the supply would have continued fit for use. The suit has been brought in the Chancery Court of the State of New Jersey, and has been joined in by the attorney-general. Among the affidavits accompanying the complaint is one from Mr. A. Fteley, M. Am. Soc. C. E., of New York city, corroborating some of the claims of the plaintiff.

The questions involved in this suit are not new, but they are none the less important. It is the old struggle over keeping streams and lakes pure for the use and delight of the public or converting them into common sewers, likewise for the use of the public, but by no means to its delight. The lower Passaic River is by nature a singularly beautiful stream. Before it was defiled, many residences were built along its course, hundreds of pleasure craft dotted its waters, and thousands of people resorted for pleasure and recreation to its banks. The residences near the river are now well-nigh abandoned. Such boats as ply to and fro do so for business purposes only. The walks and drives along the river are robbed of much of their charm by the sight and odor of the polluted stream. Besides all this, the original water supplies of Jersey City and Newark have been ruined and great damage has been done the valley in many other ways.

This mischief, however, is not all to be laid at the door of Paterson. All the most populous municipalities in the lower Passaic valley have contributed more or less to the pollution, at least all those that have found the river the most convenient place to deposit their sewage.

It is now fully recognized that the evil must be remedied. This conclusion was forced home a few summers ago, when unusually low water in the river made the stench almost unbearable to the inhabitants of portions of the valley. Agitation led to the appointment of a sewerage commission by the governor, which, early in 1897, reported to the legislature, recommending the construction of a trunk sewer down the valley to an outlet into Newark Bay. Instead of enacting a statute designed to carry out the recommendations of this commission, the legislature referred the matter to another commission, made up from its own membership. This commission has just completed a series of hearings in some of the cities and towns in the valley, and presumably will soon make a report to the New Jersey legislature, which is now in session. How soon definite action towards cleaning up the river will be taken no one can tell. The suit against Paterson, it may be presumed, will tend to impress upon the legislature the desirability of taking action at once.

Naturally enough, the situation in the lower Passaic valley has given rise to all sorts of proposals for the solution of the sewage pollution problem, and to almost endless criticisms of the trunk sewer plan recommended by the comm'sion. The mildest, perhaps, of the critics suggests that the trunk sewer should be laid in the bed of the river, in order to avoid deep cuttings and rock excavations, little thinking that submerged work of this sort might amount to double or treble the cost of land route. Other critics, notably the New York "Tribune," are appalled at the thought of the great waste of fertilizing material involved in the trunk outlet to Newark Bay. The "Tribune" says:

> The sewage of cities is too valuable to be wasted. Instead of the sewer systems being a cause of constant expense to the cities, they can be made a source of revenue.

In an earlier editorial on the same subject the "Tribune" first discusses the alleged folly and great cost of the trunk sewer, and then says:

> But it is idle to say there is no better plan. Writing in "The Passaic News," Mr. I. W. Sylvester, of that city, shrewdly suggests that if the sewer scheme is to be adopted at all, the great expense of cutting it through earth and rock might be obviated by merely laying huge pipes along the bed of the Passaic. Still better is his detailed proposal that the sewage should be piped from the cities to reservoirs on the Hackensack meadows. These might be built, at least in part, of the ashes, etc., from the cities. From them the liquid portion of the sewage would be filtered off and poured into the river in a comparatively pure state, while the solid portions, if no other use were found for them, would serve to fill up the low land of the meadows to a height at which it would be available for building purposes. This plan possesses every advantage the sewer scheme can offer, and several additional and highly important ones. It could be put into operation far more speedily; it would be decidedly less expensive; it would make permanent and beneficent use of what would otherwise be worse than wasted; and it would save not only the river but the Bay and Kills from gross pollution.
>
> Best of all, however, would it be to carry Mr. Sylvester's plan a little further and establish near those cities a series of sewage farms, on which the sewage would be disposed of in an altogether inoffensive and highly profitable manner. That would be no experiment. It would be following an example elsewhere marked with great success.

It next cites European experience with sewage farms, after which it asks and answers a question about the comparative possibilities of success with such enterprises in Europe and America, as follows:

> Are we to believe that those cities are superior to American cities in thrift, in enterprise, in cleanliness, in common sense?
>
> No; for some American cities and towns have already adopted the sewage-rendering system and are finding it profitable. One of these days they will all come to it. Chicago is spending many millions on an open sewer to carry all her drainage across the state to the Mississippi; but some now living in that city will see the absurdly vicious scheme abandoned. If the cities on the Passaic persist in this trunk-sewer folly, the present, or at most, the next generation will bitterly repent it. We shall all realize some day that pure streams were not created for pollution, and which the most rudimentary business sense should dictate—that it is better to spend money for that which will yield a profit than to spend it for that which means nothing but constant cost and irretrievable waste and loss.

In a subsequent issue the "Tribune" says that it matters little whether the cities concerned act independently or jointly, so long as the sewage is kept out of the river and bay and is utilized.

We have given space to these quotations because they go far towards expressing briefly some of the various criticisms and plans that are urged in discussing the Passaic problem, and show so well the half-truths that become rooted in the popular mind and the work that engineers must do in the way of pruning and grafting to make the half-truths grow to whole ones.

The opposition to the proposed outlet sewer to Newark Bay arises chiefly from two classes of people: (1) Those near the bay who fear that the nuisance now distributed along the lower reaches of the river will be transferred in their vicinity; and (2), those who fear that their own municipality will be called upon to bear more than its share of the expense of solving the problem, or who are opposed to the incurring of any expense for a joint scheme. Added to these is a third and much smaller class, whose principal opposition is on the broad grounds that the proposed plan is not the best one for all concerned.

The report of the original commission gives evidence of careful consideration of the relative advantages of individual and joint disposal on the part of the municipalities concerned, and of disposal with and without some form of purification. More extended study, by the same or other men, might or might not alter the conclusions laid down in the report. Until such studies are presented, however, the report certainly should deserve more credit than vague general opinions, by whomsoever expressed.

The advocates of sewage farms seem to greatly overrate the revenue that can be derived from them, and to ignore the probability that this was taken into consideration by the commission. It should be borne in mind that the moment serious proposals are made for the establishment of sewage farms or other purification works near any of the cities or towns in question just as strong objections will be forthcoming as now arise from Bayonne against the Newark Bay outlet. They may be equally well-founded or equally ill-founded, but they will arise. East Orange constructed and operated purification works some ten years ago and recently abandoned them, sending its sewage through Newark to the Passaic River. One of the principal causes leading to this change was the objections urged against the works by the people residing in their vicinity, especially those in one of the adjoining townships. Another municipality in the Passaic valley, but in the upper portion, has built and still operates purification works. Although the Summit plant is located in a sparsely settled region, the people in the vicinity have complained that it is a nuisance, and have threatened, if not instituted, suits against its operation. Still another suburban New Jersey village, South Orange, has been compelled to abandon its plans for purification works, although it had purchased land for the purpose, owing to the opposition of the town in which the land is located, both in the state legislature and in the courts. This village is now about to construct an outlet sewer to tide water. Plainfield, N. J., has established a sewage disposal area near a fairly well populated district, but it is threatened with injunction or damage suits.

In citing the above instances we are not trying to show that sewage farms or other sewage purification works are nuisances, but merely that their location in populous districts meets with just as strenuous objections as Bayonne is making against the discharge of sewage from the proposed trunk sewer into Newark Bay. Under proper conditions the discharge of crude sewage into salt or other bodies of water will create no nuisance. The engineers for the Passaic commission assert that those conditions exist in the case of the proposed outlet. They have investigated the subject with far more thoroughness than anyone, engineer or otherwise, who has yet opposed the plan, so far as has come to our notice. The alternative plans of disposal are bound to meet with equally strong

objection from the people living in the vicinity of any proposed purification works. In short, any practicable plan of disposal will meet with objections from people claiming that they will be subjected to a nuisance.

As to co-operative rather than individual disposal, a number of the municipalities in the lower Passaic valley have already constructed joint outlet sewers. East Orange has been mentioned as abandoning its purification works and conveying its sewage through Newark to the Passaic River. The outlet sewer through Newark was paid for jointly by the two municipalities named. Orange, Montclair, Glen Ridge and Bloomfield also have a common outlet sewer to the Passaic River, though none of them border on that stream. Municipalities in other drainage areas, near by, have constructed or are constructing joint outlet sewers. Outside of New Jersey the Metropolitan Sewerage System for Boston and numerous other cities and towns may be mentioned as an example of joint trunk sewer construction, surpassing by far in magnitude what is proposed for the Passaic valley. In other lines of co-operative work in the Passaic valley and vicinity the Essex County Park Commission is expending $2,500,000 for a park and parkway system; Hudson and Essex counties recenly voted bonds to build a bridge over the Passaic River; Newark and Jersey City have each for years past supplied water to adjacent municipalities, and to-day both these cities and many other municipalities, which, like Newark, are in the Passaic valley, are supplied with water from the pipe line built a few years ago by the East Jersey Water Co. for Newark.

Doubtless further study is needed before deciding upon the details of a plan for the sewage disposal of the Passaic valley. This the commission recognized in its report. It may be that more extended investigation could be had with profit before fixing upon the main outlines of a plan for disposal. But the situation demands prompt action along some line, and above all the sinking of local and personal jealousies in order that the most thorough co-operation may prevail in planning and carrying out the work. Whatever the best plan of disposal may be, there seems to be no question but that one joint scheme will be far more economical, and in the long run much more satisfactory from both the sanitary and popular sides, than independent action by the several towns and cities interested.

LETTERS TO THE EDITOR.

Increase of Bridge Strains with Velocity of Trains.

Sir: In your issue of Jan. 27, in "Answers to Correspondents," you hold up to ridicule a statement which, to my mind, is particularly lucid and concise, intended, as it was, for non-technical readers. I refer to your comment on the answer to "Measure," in the "Brooklyn Eagle," regarding the effect of moving trains on bridges. With one exception his answer is correct, as I will endeavor to prove presently. His statement: "The strain produced will vary with the square of the velocity," should not be taken literally, as you have so done, for then, with no velocity, we should have no stress, which is self-evidently impossible. He undoubtedly means that the stress produced by the velocity is proportional to the square of the same. Neglecting this slip of the pen, his explanation is correct. In the sixth edition of Merriman's "Mechanics of Materials" we find the following formula for T, the total maximum stress produced by a train moving over a beam of uniform cross section, to be

$$T = S\left(1 + \frac{5\,W\,l\,v^2}{48\,E\,I}\right)$$

in which W = total weight of train on bridge.
S = stress in lbs. per sq. in. which would be produced by W as a static load.
l = length of span in inches.
v = velocity of train in inches per second.
E = coefficient of elasticity of material.
g = acceleration due to gravity in ins. per sec.
I = moment of inertia of cross section.

From this we see that the stress due to the velocity alone, other things being equal, varies with the length of span and the square of the velocity.

As an example I will take a steel plate-girder, with a span of 80 ft., a depth of 7 ft. 2 ins., and a moment of inertia of about 112,000. Let it be required to find the stress at the middle due to a uniform load of 1,800 lbs. per linear ft. moving over it at velocities of 20, 40, 60 and 80 miles per hour. The following are the results:

For W as a static load S = 5,545 lbs. per sq. in.
" W at 20 miles per hour T = 5,552.65 lbs. per sq. in.
" W " 40 " " " T = 5,575.60 " " " "
" W " 60 " " " T = 5,613.85 " " " "
" W " 80 " " " T = 5,667.40 " " " "

Now, subtracting 5,545 from each of the above results we have 7.65, 30.60, 68.85, and 122.40 lbs. per sq. in. as the stresses due to the velocity of the train at 20, 40, 60 and 80 miles per hour. These results are directly proportional to the squares of the velocities.

The above formula is not true for extremely high velocities, for when a certain limit is reached the load cannot fall, under the action of gravity, as much as the static deflection of the girder, and the stress might become less than S. Further, the velocity could become so high that no deflection at all would occur and therefore no stress. However, the above formula is probably correct up to velocities near 500 miles per hour, after which the total stress may vary in some inverse ratio of the velocity.

Yours very truly, Frank O. Dufour.
South Bethlehem, Pa., Feb. 8, 1898.

Contour Maps from a Preliminary Survey.

Sir: I send you a short description of a method I have found very useful in taking side elevations from a preliminary line, in railway work, in order to make a contour map upon which a location may be laid down. Under proper conditions, I find it the most expeditious method of getting the necessary detail notes. The method is new to me, and is described as follows:

One method of making a railroad location is to first run a preliminary angular line, take elevations at points on this line, and then, using these elevations as a basis, sketch in the contours, and from the working map thus made fix the location line. The contour map is best made on sheets of paper, about 18×24 ins., which are attached to a small drawing board and carried into the field. While the elevations on the preliminary line serve as a basis, the elevations of other points at the side of the line must be taken to make a good map. Some engineers actually locate the contours in the field, while others take simply the elevations of points where the slope of the ground changes considerably—i. e., simply the ruling points, and sketch in the position of the contours between these points.

In obtaining the elevations of these ruling points, the writer has found the Abney level very convenient when used in connection with the diagram here shown. By this method the work is best carried on by three men—a topographer and two chainmen. They start with a point of known elevation, usually a point on the preliminary line. The mode of working is as follows: One chainman, A, uses the Abney level and holds one end of the tape, while his fellow-chainman, B, carries a small rod with a mark on it at a distance from the end equal to the height of A's eye above the ground. Now, let A stand on the preliminary line at a point of known elevation; B goes to a second point, a ruling point, whose elevation is desired, and they stretch the tape between them, measuring along the slope the distance to the second point. Then A measures the vertical angle by sighting at the marked point on B's rod, and the horizontal distance and the difference in elevation are readily found from the diagram with the data thus secured.

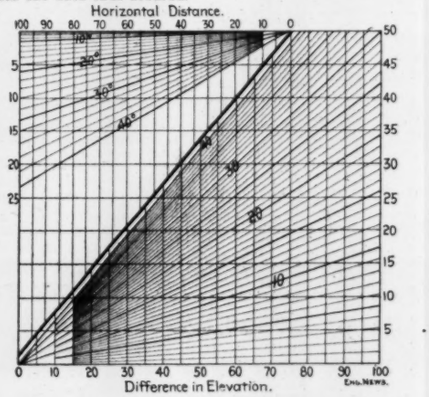


Diagram for Obtaining Difference in Elevation and Correction in Measured Distance, to Obtain Horizontal Distance. (Used in Connection with Abney Level.)

This diagram is used as follows: For difference in elevation use the lower portion. Follow along the lower set of figures to the slope distance measured, or interpolated on the diagram; thence follow up a vertical line from this point to the inclined line corresponding to the vertical angle; thence out to the right hand edge and read the difference in elevation.

For the horizontal distance use the upper diagram. Follow along the upper set of figures to the slope distance measured; thence downward to the inclined line corresponding to the vertical angle read; thence to the left and read a quantity, which must be subtracted from the slope distance measured to give the horizontal distance required.

If several points are wanted in the first 100 ft., a 100-ft. tape being assumed, they can all be taken while A is standing on the preliminary line. If it should be necessary to go out more than 100 ft. the elevations are simply obtained by "pegging" out by using vertical angles and slope distances, from which horizontal distances and differences in elevation are obtained, as before described.

By this method the work can be done rapidly, as the distance moved out at each "pegging" may be nearly 100 ft., whereas, with the hand level, or slope rod, it is generally less. By measuring on the slope the trouble of "breaking chain" is avoided, with a consequent saving of time. The diagram is small and is therefore readily fastened to the field drawing board with thumb tacks, so that it will not be in the way. If the ground is nearly level, it is often more expedient to set the Abney level to read zero angle and then use it as an ordinary hand level.

Very respectfully, H. I. Randall,
Asst. Prof. Civil Engineering.
Berkeley, Cal., University of California,
Dec. 22, 1897.

Notes and Queries.

L. L., Budapest, Hungary, inquires the name of the author or publisher of two German pamphlets, one entitled "Modern House Moving and Shoring," and the other, "The Raising and Moving of Buildings Bodily."

E. S., Oshkosh, Wis., asks: "What is the life of cast iron water pipe underground with direct pressure?" It depends on the character of the soil in which it is laid, of the water which passes through it, of the coating with which the pipes are covered and perhaps also upon the kind of metal in the pipes. Under some conditions pipe might be useless in a dozen years or less, whereas under other conditions its life is so long that experience has not yet enabled a limit to be set.

CHANGES IN FOUNDRY MIXTURES.*

By Eugene W. Smith.

The members who discussed the effect of blast at the meeting in February, 1897, practically agreed that there was a difference in the first iron melted, but did not go far enough and find the cause, which the writer thinks might be attributed to some mechanical change, as expressed in this paper. Every now and then some one gives a theory to explain why the first iron is harder than the last, and somebody else gives a reason why it is softer, each demonstrating the matter to his own satisfaction in scientific terms. All conditions being equal, results should be the same, no matter at what period of the heat the charge is melted, the differences being due simply to some mechanical change due to handling. Some of these changes the writer will try to describe in the present paper, showing the absolute care which must be taken in handling to obtain uniform results.

1. A very common source of error occurs in the charging room in weighing up the charges. Sometimes a certain brand of iron is not broken as small as others and the charger is not careful as to balancing his scales, causing variations at different times during the heat.

2. The placing of iron in the cupola in such a manner as to cause uneven melting, allowing one brand to melt and mix ahead of others, frequently causes trouble.

3. Improper drying of the cupola is probably one of the most frequent causes of hard iron in the beginning of the heat, particularly so if the receiving ladle, hand ladles, etc., are not thoroughly dry, or even cold, causing changes in the condition of iron by chilling.

4. Probably the most important cause of change in the first iron melted is the excessive use of blast. The fuel resembles an open net-work, somewhat like a sponge, unobstructed by slag, which does not begin to form until considerable iron has been melted. If conditions are otherwise all right, the iron will be exposed to the oxidizing effect of the blast while trickling through the fuel, serving to harden it. This is generally attributed to a chemical change caused by sulphur in the bedcharge of fuel. But there is no good reason why the sulphur should predominate any more in the first charge than later in the heat. It is also attributed to the destruction of silicon, which is probably the true effect, but not the cause.

5. Another source of error occurs where the iron is drawn off faster than it is melting, not allowing it to mix properly, thus obtaining hard iron at one time and soft at another.

6. A change in condition occurs where the slag-hole is used and the cupola is held too full, allowing the slag to clear off the iron, thus exposing it to the oxidizing effect of the blast.

7. Still another change is caused where the lining of the cupola has been too hot in drying out, which sets fire to the fuel charges above the melting zone at one side of the other, causing the stock to come down unevenly.

8. Very often the tuyeres are formed unevenly, with larger openings on one side than the other, causing the stock to melt faster on one side, thus giving an uneven result.

Another instance occurs where economy in the use of fuel is practiced. The bed may be all right and the heat

*Abstract of a paper read at the meeting of the Western Foundrymen's Association, at Chicago, Feb. 16, 1898.

started successfully, but by the excessive use of blast the bed of fuel is gradually decreased, until at last, when charging is all done, and the doors closed, the iron melts too close to the tuyeres, which is almost invariably the cause of hard iron. Soft fuel under the same conditions would likely have the same result. In the above case an excess of thin fluid slag, about the concistency of soap-suds will be noticed, very foamy and light; and if the blast is excessive, the slag will be held up by its pressure around the sides of the cupola, also giving off a peculiar puffing sound very easily noticed. It cannot be drawn off until the blast pressure has been reduced, which must be done gradually and carefully, or the slag will flow into the tuyeres first. The hard iron in this case could be attributed to the destruction of the metalloids, nevertheless it is a mechanical change in the mixture which would not have happened if the melting had been done properly.

The above items only apply where the iron melted does not exceed eight tons per hour and the stack does not exceed 48 ins. diameter. They do not apply to any particular grade of mixture, for the effects would probably be the same whether hard or soft irons were melted.

INTERCEPTING SEWERS ON 12TH ST. AND 22ND ST., CHICAGO.

The sewerage system of the city of Chicago is to be radically changed by the construction of intercepting sewers to carry the sewage to the Chicago River, from which it will flow through the Illinois & Michigan Canal until the completion of the Drainage Canal. These new sewers, which will cost (with pumping plants) about $3,300,000, will thus prevent future sewage pollution of the waters of Lake Michigan, so that the city will be assured of a pure water supply. The necessary ordinances have been passed, the general plans have been approved by Mr. L. E. McGann, Commissioner of Public Works, and the construction is to be commenced and carried on as quickly as possible. The

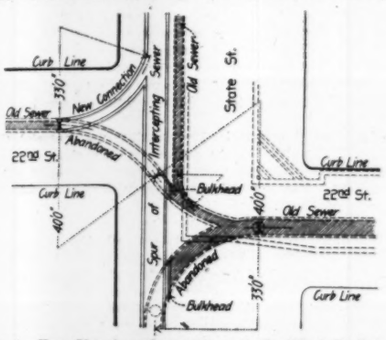


Fig. 1.—Map Showing Connection of the 22nd St. Intercepting Sewer with Existing Sewers at State St. and 22nd St., Chicago.

intercepting system was described in our issue of Feb. 10, and we describe herewith the first two sewers, which will be built on 12th St. and 22d St. Although these are not the largest or longest sewers of the system they form every important part of it, since they will intercept about 40% of the Chicago sewage now discharged into the lake. The plans and specifications have been prepared by Mr. F. E. Davidson, M. Am. Soc. C. E., Superintendent of Sewers, to whom we are indebted for the blue prints from which our illustrations are prepared.

Twelfth St. Sewer.

This will commence at the west line of the Illinois Central R. R. property, and go west on 12th St. to State St., then south to 14th St. and west along 14th St. to the Chicago River. The diameter will be as follows:

Diameter, ft.	Length, ft.	Average depth, ft.	Manholes built.	Catchbasins—Built.	Catchbasins—Reconnected.
4	810	13.9	7	..	8
4½	400	13.9	3	1	2
5¼	1,250	14.3	10	..	4
5½	1,075	14.4	8	..	10
Total.....	3,535		28	1	24

Besides this, there will be 60 ft. of 2½-ft. sewer at the intersection of State and 12th Sts.; also old sewers to be removed along the line of the new sewer, and 16 sewers to be taken up for about 20 ft. at street intersections and connected to the new sewer. The fall will be about 1 in 2,000. The sewer will take a diagonal line across State St. at 12th St., with two curves of 50 ft. radius connecting this with the sections on the two streets, but from State St. to 14th St. it will make a right angled curve of 50 ft. radius. The portal will be of masonry, on a timber platform supported by oak piles and caps, with plank sheeting at the sides and front.

Twenty-second St. Sewer.

This will commence at South Park Ave. and 22d St., following the latter to Prairie Ave., thence to 21st St., continuing then along 21st St. to Stewart Ave., where it changes its direction by reverse curves of 100 ft. radius under the network of railway tracks, and then across South Canal St., and on to its outfall into the river at Todd St. The work on this sewer will be as follows:

Diameter, ft.	Length, ft.	Average depth, ft.	Manholes built.	Catchbasins—Built.	Catchbasins—Reconnected.
5¼	2,221	16	15	..	26
8	3,287	14.5	14	2	30
Total.....	5,508		29	2	56

Besides this, there will be the concreting of 104 ft. of a 6-ft. sewer to change the direction of its flow, and the construction of 30 ft. of 2½-ft. wing sewers at Prairie Ave. and 22d St. Also two additional manholes and two catchbasins, the taking up of six sewers on the line of the new sewer, and taking up (for 20 ft.) and reconnecting about 24 intersecting sewers. In crossing both Wabash Ave. and State St. the line of the sewer has to be diverted to avoid the wheel-pits of the cable railways, and this is done by reverse curves of 40 ft. radius on each side of Wabash Ave., and reverse curves of 30 ft. radius at the middle of State St. A spur of 518 ft. of 6-ft. sewer will be built on State St. from 21st to 22d Sts., where it will connect with an existing sewer by 52 ft. of 3-ft. sewer, changing the direction of the flow of old sewer, as shown in Fig. 1. There will be a short section of tunnel where the 8-ft. sewer passes under the elevated tracks of the L. S. & M. S. Ry. and C., R. I. & P. Ry.

The east end of the sewer will be formed by 104 ft. of an existing 6-ft. sewer, but as the grade of the latter is now towards the east, a concrete floor will be put in on the present brick invert, forming a narrow channel with a grade of 0.058% to the west. A short tapered section will connect this old 6-ft. sewer with the new 5¼-ft. sewer. This concrete filling is shown in Fig. 2. An opening in the concrete will be left at each intersection, with junctions for catchbasins, etc. Where less than 6 ins. of concrete is required on the bottom of the present sewer, the inner ring of brick will be removed for a width of 16 ins. All other parts of the invert which will be covered by the concrete will be thoroughly cleaned by washing with diluted muriatic acid, then with a solution of potash or concentrated lye, and lastly with water. All this will be done by the contractor. The concrete is to be mixed with as little water as possible, and is not to show the gelatinous or liver-like motion which has been specified of late by some Chicago engineers. This is shown by the following extract from the specifications for this part of the work:

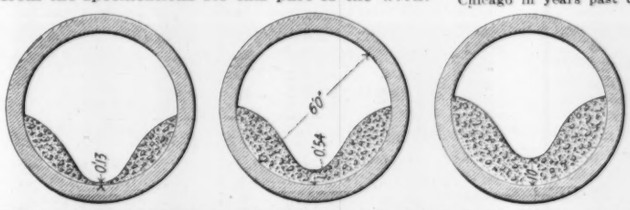


FIG. 2.—NEW CONCRETE FLOOR TO CHANGE THE DIRECTION OF GRADE IN A 6-FT. SEWER.

After the sewer is properly cleansed, the concrete shall be put in place and rammed as specified. Templets or forms shall be set and secured, and the concrete shall be brought up just slack of a line or straight-edge set on these forms. It shall be thoroughly rammed, and immediately finished with a coat of Portland cement mortar, not more than ¾-in. thick, composed of 1 part cement and 2 parts screened torpedo sand, floated down truly to the line between forms and troweled smooth.

The concrete must not be dropped from a height when deposited. Each stone shall be thoroughly coated with mortar. The batch of concrete must be spread in a layer 3 to 4 ins. thick upon the bottom of the invert and rammed thoroughly with repeated, but not hard, blows with a 15-lb. iron-shod rammer, until a thin film of water appears on the surface, and all the stones have been driven out of sight without causing in the mass a gelatinous or quicksand motion, which indicates an excess of water.

Methods of Construction.

The specifications for these sewers have been drawn up with great care, with special regard to ensuring a fair but rigid contract and to reducing the extras as far as possible. The price bid per lin. ft. of sewer is to include every kind and character of work. The sewers will be built in open trenches protected by 2-in. sheeting, the width being 3 ft. greater than the outside diameter of the sewer. The sewer bricks will be 8 × 4 × 2½ ins., hard burned, and giving a clear ringing sound when struck; after being dried and then immersed in water for 24 hours they must not absorb more than 10% in weight of water. For diameters of 6 ft. and under, two rings of brick will be used, and three rings for diameters of 6 to 8 ft. The bottom of the excavation will, as far as possible, be shaped to fit the outside of the sewer, and this will be effected by means of two sets of patterns or forms, one for the outside and the other for the inside of the invert. Where this cannot be done on account of the character of the soil, the extra space outside the line of the sewer must be filled with concrete or brick masonry. For pipe sewer connections, vitrified, well-glazed pipe will be used, varying in thickness from ⅞-in. for 9-in. to 1¼ ins. for 18-in. pipe.

The manholes will be circular, 3 ft. diameter, built of two rings of brick, giving an 8-in. wall, the bricks in the inner ring being set vertically. The tops will be 2 ft. in diameter for iron covers (reduced by 12 header courses, decreasing the diameter 2 ins. in each course), and 2 ft. 8 ins. for wooden covers. Catchbasins will be 4 ft. inside diameter, built of two rings of brick, the same as the manhole, upon a floor of 6 ins. of concrete, with 9-in. half-trap and 9-in. pipe to the sewer.

The outfalls will be of brick and rock-faced stone, on a foundation of white or burr oak piles, 25 ft. long, 12 ins. diameter at the butt and 8 ins. at the small end. The heads will be tapered and driven with a hood. On the piles will be oak caps 12 × 12 ins., secured by ⅞-in. drift bolts 22 ins. long. Each foundation will be anchored by two 1¼-in. rods, each carried back to an anchor pile or deadman, set 20 ft. back from the face of the outfall. On the inside of the front rows of piles will be two waling pieces, 3 × 12 ins., and one 3 × 6 ins., secured by 1-in. bolts, and a close sheeting of 3 × 12-in. planks will be driven behind the waling pieces and secured by spikes. On the caps will be a floor of two courses of 3 × 12-in. planks, the first course laid across the caps and the upper course parallel with the caps, all fastened by wrought-iron spikes. All the timber will be of oak. The construction of the outfall of the 8-ft. sewer is shown in Fig. 3.

Cement, Mortar and Concrete.—The following is an abstract of the specifications for materials:

The cement shall be fresh made, of some satisfactory and reliable brand, and of such quality and uniformity as has been demonstrated by the Department of Public Works of Chicago in years past to be of superior quality and thoroughly adapted to the construction of sewers and similar work and shall be approved by the engineer.

Natural cement shall be so finely ground that 80% of the whole will pass through a sieve of 80 meshes per lin. in., and when tested in the usual manner for tensile strength shall give results comparing favorably with the best brands of American natural cement. Portland cement shall be American, Swedish or German Portland cement of reputation known and established by use. It shall be ground so that 93% will pass a standard sieve of 10,000 holes per sq. in. A mixture of 1 part cement and 3 parts sand shall show a tensile strength of 165 lbs. per sq. in. in 7 days (1 day in air and 6 days in water), and an increase of not less than 33% in strength at the end of 28 days, and an additional increase of 15% at the end of 3 months.

As ample time is allowed, the contractor shall submit samples of the Portland cement he desires to use, and three to five brands may be approved by the engineer, any of which the contractor may use.

The mortar shall be made by carefully measuring and thoroughly incorporating 1 part of cement with 2 parts of clean, sharp sand in dry state, and mixed with clean water to the proper consistency, and shall be used while fresh;

the use of mortar which has been set and then retempered will not be allowed. The mortar used in laying pipe sewers shall be of pure cement, mixed and used as above specified, all to be furnished by the contractor without extra charge.

All concrete shall be composed of 1 part Portland cement, 3 parts clean torpedo sand free from loam and dirt, and 9 parts of broken stone; the stone to be of good quality,

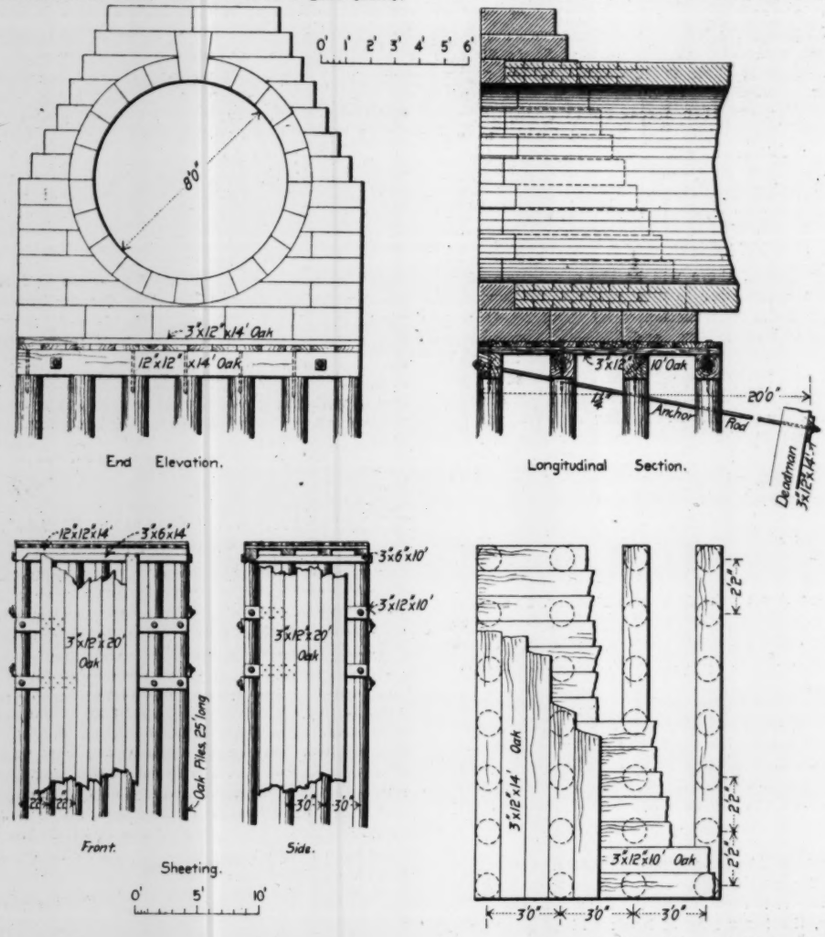


FIG. 3.—OUTFALL OF THE 22ND ST. INTERCEPTING SEWER AT THE CHICAGO RIVER.

graduated in size, angular in shape, and free from dirt or clay. Quarry strippings will not be allowed. All stone must be broken so that the largest size shall not exceed 1 in. Concrete used for foundations shall be composed of 1 part best Portland cement and 4 parts clean torpedo sand free from loam or dirt, and 12 parts of broken stone. The cement and sand shall be measured and shall be thoroughly mixed, dry, until of a uniform color, and shall be wet through a rose-head with as little water as will render the mortar proper for use, and thoroughly worked. The stone shall be measured and spread about 4 ins. thick on a tight board platform. The mortar shall be spread evenly on the stone, and the whole shall be turned in place with shovels without heaping until each stone is thoroughly coated with mortar. The stone shall be wet or washed, if required, before the mortar is spread.

The requirements for backfilling are that after the arching is completed, on any length of sewer, and before the centers are struck, the trench is to be filled to a height of not less than 2 ft. above the arch. On brick sewers, the spandrel filling is to be well consolidated to a height of 6 ins. above the crown of the arch by thorough ramming, whenever the ground is of a nature to admit it. As soon as the mortar and masonry are sufficiently set, the trench is to be sufficiently filled to prevent liability of injury to the street surface, pipes, railway tracks, sidewalks, etc. In paved streets, if the backfilling is of clay, stiff loam or other tenacious material, it is to be well rammed in 6-in. layers; if it is of sand or gravel it will be puddled. The backfilling must be left with a smooth and even surface, and not left unfinished for more than 200 ft. behind the completed sewer work.

The use of concrete instead of brick masonry for these sewers was suggested at one time, and was in fact recommended by an aldermanic committee which visited Reading, Pa., to examine the concrete sewers at that place. The committee, like most of its kind, was not competent to judge of engineering matters, and as it heard that concrete was suitable at Reading, jumped to the conclusion that it would be suitable at Chicago. As a matter of fact, the greater part of the intercepting sewers will be built in blue, running quicksand, and as it would be almost impossible to keep running water out of the trench there would be great probability of the cement being washed out of the concrete, besides which it would be difficult to ensure absolute compliance with the terms of the specifications as to the quality of the concrete. For these and other engineering reasons, as well as on account of the fact that concrete sewers have been tried and found an expensive failure in the Chicago quicksand, the officers and engineers of the public works department declined to consider the use of concrete for this important work.

FLUSHING CULM INTO ANTHRACITE COAL MINES.

During the past few years it has become the practice at some anthracite coal mines to carry back into the worked out rooms of the mine the fine culm and refuse from the breakers and old culm banks, packing it in so as to support the roof and allow the pillars, which constitute about one-third of all the coal in a mine, to be withdrawn. At a recent meeting of the Anthracite Coal Operator's Association a committee was appointed to investigate and report on this subject, and its report is printed in the Association's "Letter" for February. It was written by Mr. James B. Davies, superintendent of the "Black Diamond" and "Dodson" colleries, near Wilkesbarre, and describes the method of "flushing" the culm; that is, carrying it in a current of water in iron pipes into these two colleries. The first experiment was made in the Dodson mine in 1891, and it has been in successful operation ever since. The system of operation is described in the report as follows:

a. Outside.—A small tank is set under the chute that takes the dirt from the buckwheat screen. The dirt and water go into this tank together and enter a pipe down the shaft into the mine.

b. Inside.—This pipe is continued along the [illegible] gangways and airways from bottom of the shaft [illegible] branch turn-off by means of three ways and elbows into the different chambers. At the bottom or the entrance to these chambers, a wall is built—well timbered on the gangway side, to dam the dirt that comes from the pipe. If the pitch of strata is light, the culm pipe must be brought down near this wall and the whole length of the chamber. The mouth of the pipe is raised against the roof in order to completely fill this section. When this is done the contents of the main culm pipe must be turned into another chamber while the men are taking so many lengths of pipe off in the first chamber to give it another section to fill. When this is ready, they must do the same with chamber No. 2. The pipe goes into the chamber in, or as near as possible to, the face, and continues to fill them thus, upwards. The lighter the grade the more expensive the work is. The pipe must be put in nearly the whole length of the chambers and must be taken out as they fill up.

1. Size of Pipe.—At the Dodson mines we use 6-in. pipe from the culm plant down the shaft and along the gangways, but in branches that turn to different chambers we use 4-in. and 5-in. pipes. At the Black Diamond mines we use two lines of pipe—one 3-in. line, which takes the breaker culm into the mines, and the other, 4-in., which takes the bank culm to different points in the same veins.

2. Nature of Pipe.—We have tried three different kinds of pipe—wrought iron, steel and cast iron pipes. The first is the best. The second is too soft and will soon wear out, while the third is harder than either, but the friction of the culm in flowing through makes it very rough. On account of this roughness the friction becomes very great and the casting is soon eaten out.

3. The Wear of Pipes.—The wear of the pipe used depends on the nature of the water and the material that is to be treated. With fresh water and small culm from the buckwheat screen, it will last some eighteen months. When carrying bank culm from dust to pea coal and some chestnut, it will last say nine months. When this is mixed with ashes, it will not last more than six months. When small culm from the buckwheat screen and bank culm run together through the same pipe in the ratio of two small sizes to one large, the pipe will last some twelve months.

4. Best Sized Material.—The smaller the material the better. The pillars in the mines are full of cracks and crevices—sometimes these run half way and often through the pillars. This depends on the nature of the coal and the size of the pillars. If these pillars are to be made solid, the water must carry very small particles of culm, so that they can pass to the farthest end of these crevices and fill the pillar. The smaller the material the less water will be required to carry it through. The reason for this is obvious. The larger the material the more space between the particles and the quicker the water will travel—it will travel faster than its load. But when its load is ground from rice size to dust, it is easier for the water to take it along than to penetrate through and leave it behind. Also, when small material comes in contact with the pipe, it creates little friction and the pipe will wear better, which is just the reverse in carrying the larger sizes.

5. Blocking of the Pipe.—It is quite a problem to run the pipe from one place to another without interrupting the stream of culm and prevent it blocking from the face of the mines to the breaker. When this happens the culm must be taken care of in the usual manner by taking it out to the bank until the pipe is cleaned out. This blocking seldom happens with the pipe that carries the small material from the buckwheat screen, but it will happen to the culm bank plant pipe about three times a month. This also proves the importance of having enough crushers to grind the culm to the proper size.

6. Kind of Water.—By all means it should be fresh. Dodson gets its water from the Susquehanna, and the Black Diamond from Toby's Creek. Mining water was tried at both places, but proved injurious to both pipes and pumps. Whatever may be the original percentage of sulphur in this mine water, it is increased twofold when it returns after washing the culm down the mines.

7. Amount of Water.—The Dodson culm pipe is 2,500 ft. long. 1½ lbs. of water will deposit 1 lb. of breaker culm; 2 to 2½ lbs. will deposit 1 lb. of bank culm. Black Diamond breaker culm pipe is 2,924 ft. long. 1½ lbs. of water will deposit 1 lb. of breaker culm at this point. Black Diamond culm pipe is 5,624 ft. long. 2 to 2½ lbs. of water will deposit 1 lb. of bank culm at this place.

In the two mines, "Dodson" and "Black Diamond," there have been flushed 74 acres to the thickness of the vein, equivalent to 573 acres 1 ft. thick. The amount of coal saved by flushing the mine, due to the coal enabled to be recovered from the pillars, is estimated to be from a fifth to a seventh of the total coal originally in the mine.

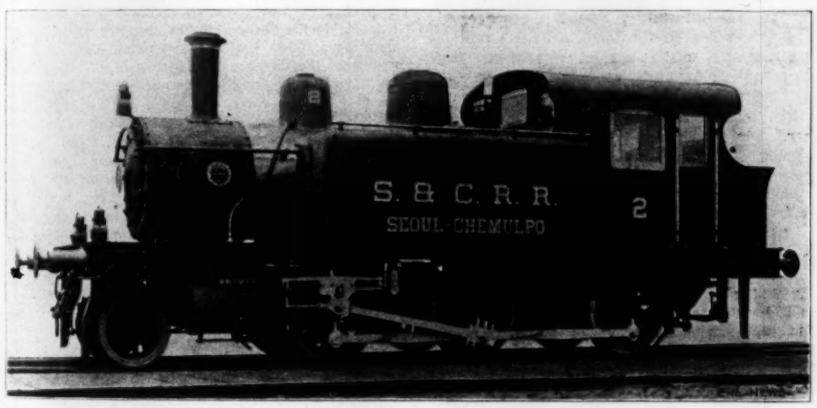
The report goes into considerable detail regarding the construction of a flushing plant and its cost.

The advantages of running the culm back into the mine are: 1. The saving of the ground space occupied by culm banks above ground, which space if it is located near towns may be valuable. 2. The saving of expense in handling culm, since it is cheaper to run it into the mine through the flushing pipes than to haul it to the culm dump. 3. The saving of the coal from the pillars. The amount of coal left in the pillars is about one-third of the vein contents, and seven-eighths of this is obtained by filling with culm and removing the pillars in places where it is necessary to support the roof.

AMERICAN LOCOMOTIVES FOR COREA.

In 1897 the government of Corea granted to an American firm the concession for the first railway in that country, the line extending from Chemulpo, the principal seaport, northward to Seoul, the capital city, a distance of about 25 miles. The road is of standard gage, 4 ft. 8½ ins., and its construction and equipment have gone steadily forward. The Brooks Locomotive Works, of Dunkirk, N. Y., has received, through the American Trading Co., of Yokohama, an order for four locomotives for this line, and one of these is shown in the accompanying cut.

It is a tank engine of the mogul type, with side or wing tanks on each side of the boiler, and a rear coal bunker behind the enclosed steel cab. The tanks are supported by iron frames extending between the front and back bumper beams (which are steel channels), and are held in place by flat plates bolted to the end plate of the tank and an angle iron rib on the boiler. The side plates are curved to form the top of the tank. The boiler is of the straight-top pattern, with extension smoke-box, and the whistle and safety valves are mounted on a special fitting independent of the dome. The smokebox front and door are of pressed steel. All the rods are of rectangular section, the side rods being fishbellied in shape, with solid ends. The Detroit sight feed lubricators and the Hancock injectors are used, and the driving wheels are fitted with steam and hand brakes. Bituminous coal will be used for fuel.



TANK LOCOMOTIVE FOR THE SEOUL & CHEMULPO RY., COREA.
Brooks Locomotive Works, Dunkirk, N. Y., Builders.

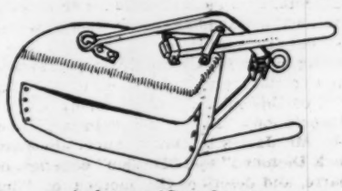
Like the American locomotives for Japan, illustrated in our issue of Feb. 3, these engines have no headlight or pilot, but small lamps for markers, and are also fitted with spring buffers, screw couplings and "knives" in front of the wheels. Steel fireboxes and iron tubes are used, however, instead of the copper fireboxes and brass tubes of the engines for Japan. The leading dimensions of these Corean engines are as follows:

Dimensions of Mogul Tank Locomotives; Seoul & Chemulpo Ry.

Running Gear:	
Driving wheels (6), diameter	3 ft. 6 ins.
Truck wheels (2), diameter	2 " 4 "
Driving wheel centers	Cast-iron.
Journals, driving axles	6 x 7½ ins.
Wheelbase: Driving	12 ft. 3 "
Total engine	19 " 0 "
Center engine truck-pin to c. leadg driv. wheel	6 " 9 "
No. and order of wheels having blind tires	Middle pair.
Weight in Working Order:	
On driving wheels, average, 65,000 lbs.; max.,	67,600 lbs.
On truck wheels, average 10,000 " "	11,000 "
Engine, total 75,000 " "	78,000 "
Cylinders.—No.	Two.
Diameter and stroke	14 x 22 ins.
Conn. rod, length bet. c. 5 x 8½ ins.; side rod, solid ends.	
Valve Gear.—Type	Link.
Ports, steam 1⅞ x 12 ins.; Ports, exhaust.	2½ x 12 ins.
Bridges, width	1⅜ "
Slide valves, style, Richardson; Max. travel	5¼ "
" " inside lap, 3-32-in.; outside lap	⅜-in.
" " lead (full forward gear)	None.
Boiler.—Type	Straight top.
Diameter barrel, inside smallest ring	3 ft. 10 ins.
Dome, diameter	1 " 10 "
Thickness, barrel plates	⅜-in.
Smokebox tube-plate	½-in.
Horizontal seams	Quadruple riveted.
Circumferential seams	Double riveted.
Height from rail to center line	6 ft. 2 ins.
Length of smokebox (including extension)	3 " 11½ "
Form of spark arresting device	Wire netting, No. 12 gage, 2½ x 2½-in. mesh.
Injectors	Hancock.
Working steam pressure	140 lbs.
Firebox.—Type (steel)	Deep; radia.-stayed.
Length, inside 4 ft. 6 ins.; width, inside	2 ft. 11 ins.
Depth at front and back	4 " 10½ "
Thickness, side plates ⅜-in.; back plate	5-16-in.
" crown plate ⅜-in.; tube plate	½-in.
Kind of crown stays	Radial.
Kind of grate bars	Rocking.
Is fire-brick arch used?	Yes, on studs.
Water spaces, width at front (top)	3½ ins.
" at back and sides	4 "
Tubes.—(Charcoal iron); No.	122
Thickness	No. 13 B. W. G.
Diam., outside, 2 ins.; length over tube plates 9 ft. 1 in.	
Heating Surface and Grate Area:	
Heating surface, tubes, (interior area)	575.00 sq. ft.
" firebox	71.20 "
" total	646.20 "
Grate area	12.66 "
Miscellaneous:	
Exhaust nozzle (single, permanent), diam., 4, 4 3-16, 4⅜ ins.	
Exhaust nozzle, distance above center line of boiler	13 "
Smokestack, diameter at top	12⅜ "
" diameter at base	10 "
" height above smokebox	3 ft. 1 "
" height of top above rail	11 " 2½ "
Capacity of tender tank	1800 gallons.
" " coal space	2,240 lbs.
Brake fittings	Steam and hand on driving wheels.
Total adhesive tractive power at ¼ of weight on driving wheels	16,250 to 16,900 lbs.

AN IMPROVEMENT IN DRAG SCRAPERS.

The accompanying cut represents a new design of drag scraper, the special feature of which is the form of the bottom plate riveted to the underside of the scraper. This plate is of ¼-in. steel, and is bent so that at one point it projects ¾ to 1 in. below the scraper, the sides being flanged so as to prevent dirt from getting between the plate and the scraper. The shorter end of the plate is 7 to 9 ins. long, with its front edge beveled so as not to offer any obstruction in loading, while it serves to stiffen the cutting edge. The back part of the plate is about 18 ins. long, and the rear end is carried up and riveted to the back of the scraper, so that the rivets are not subjected to



An Improved Drag Scraper.
Manufactured by the Kansas City Wheel Scraper Co.

wear. In loading, the scraper rides on the shorter end of the plate, and is easily handled. When loaded, the pressure on the handles tilts it on the ridge of the plate, and the scraper then rides on the longer back end of the plate, the cutting edge being then raised 1 to 1½ ins., so that it will not spill the contents and will not catch in small irregularities in the ground, causing the scraper to be accidentally dumped. This renders unnecessary the practice which some contractors now have, of bending up the cutting edge to prevent it from digging holes and dumping the scraper at any little obstruction. It is also claimed that the shape of the plate facilitates dumping. Another feature of the scraper is a special swivel which can be attached to the bail without cutting a hole, and thus weakening the bail at the point of attachment. The bottom plate and swivel device have been invented and patented by Mr. E. A. Brown, Manager of the Kansas City Wheel Scraper Co., of Kansas City, Mo., to whom we are indebted for the above particulars.

AN ANCIENT MAP OF PALESTINE, in the form of a mosaic pavement, is said to have been lately uncovered at Madaba, a hamlet in Palestine, beyond the River Jordan. The librarian of the Greek convent at Jerusalem thinks that it dates back to the beginning of the fifth century, and it is interesting in giving both the ancient and the contemporary name of the places depicted. It was found beneath the ruins of a very ancient church, and is almost perfectly preserved. The discovery greatly interests students of ancient geography, as reported at the last meeting of the Academy of Inscriptions and Belle-Lettres, at Paris.

ALUMINUM AS A RIVAL FOR COPPER IN ELECTRICAL CONDUCTORS.*

The present extensive use of copper for electrical conductors is due to its high conductivity, its freedom from corrosion, its ductility, considerable tensile strength, and the ease with which it can be soldered or brazed. Many other metals have been tried as a substitute only to be found wanting. Among these, aluminum most nearly fulfils the qualities of an ideal electrical conductor. Recently, through the work of the Pittsburg Reduction Co., the art of manufacturing aluminum has been brought to such a state that the question of aluminum conductors can be seriously considered. It is now possible to commercially roll rods or draw wires of aluminum much the same as with copper.

Comparing briefly some of the properties of copper and aluminum, we have:

	Specific gravity.	Conductivity.	Tensile strength, lbs. per sq. in.—Soft.	Tensile strength, lbs. per sq. in.—Hard.	Selling price, Per lb., U. S. cts.	Selling price, K l lo., Germany. marks.
Copper	8.93	98	16,500	65,000	14	130
Aluminum	2.68	63	26,000	40,000	29	280

Any given volume of copper is $\frac{8.93}{2.63}$, or 3.332 times heavier than an equal volume of aluminum. Therefore, volume for volume, with copper at 14 cts. per lb., aluminum bars or wires sold at 29 cts. per lb. would cost $\frac{29}{14 \times 3.332} = \frac{29}{46.65} = 62\%$ of the cost of copper. That is, 1,000 ft. of wire 1-10 in. in diameter would cost the same with copper at 14 cts. per lb. or aluminum at 46.65 cts. per lb.

From the standpoint of conductivity, taking copper as 100, aluminum equals 63, or if a certain section of copper is specified, to obtain an equal conductivity using aluminum, it would be necessary to increase the section 60%, or $100 \times 8.93 = 893$; weight of copper wire, $160 \times 2.68 = 428.8$; weight of aluminum wire, $\frac{428.8}{893} = 48\%$.

That is, the weight of the aluminum conductor having the same length and electrical conductivity as a certain copper conductor would be only 48% as much.

Considering next the relative cost of a mile of the two wires of equal conductivity, take as an example a mile of No. 10 B. & S. copper wire, weighing 162.32 lbs., which, at 14 cts., equals $22.72. An aluminum wire of equal conductivity would weigh 48% of 162.32, or 77.91 lbs. This weight, at 29 cts. per lb., would cost $22.59 for the mile, or 13 cts. less.

The strength of aluminum and copper rods, wire

* Abstract of a paper by Alfred E. Hunt, M. Am. Soc. C. E., President of the Pittsburg Reduction Co., Pittsburg, Pa.

and bars is, per unit of area, practically the same. For the same conductivity, however, the sections will be as 100 is to 160, hence the tensile strength will be as 100 is to 160 in favor of the aluminum, while at the same time the wire would weigh only 48% as much as the copper wire. Thus we see that there is a double gain, a 60% increase in strength and a 48% reduction in weight. Both of these factors will permit longer spans and therefore a reduction in the poles, insulators and other expensive details of pole lines. It is also possible, by proper manipulation during manufacture, to materially increase the tensile strength of aluminum wires, so that it is safe to say that hard-drawn aluminum wire has a maximum tensile strength of about 50,000 lbs. per sq. in.

Among the other excellent qualities possessed by this metal, not the least is its ability to resist corrosive action due either to the moisture in the atmosphere, as ordinarily encountered, or to sulphurous gases and other corrosives such as are found in the vicinity of railways or mills.

In moist air copper becomes covered with a green layer of basic carbonate of copper, which does not protect the underlying material, as it has a corrosive action. In the case of rail bonds, where the soil contains ammonia salts, the ammonia in contact with the copper and oxygen of the air forms a soluble cupric oxide and free ammonia. Aluminum, on the other hand, is affected differently; the first coating found in the case of contact with the moist air is alumina, or oxide of aluminum, which is a harmless salt, and forms an impenetrable coating on the metal which protects it to a large extent from further corrosive action. Ammonia, sulphur gases, etc., while effecting a certain amount of surface change on aluminum, do not corrode it to such an extent as copper. Among the many uses to which aluminum can be put in the manufacture of electrical apparatus it suffices to mention one, its adaptability to spacers, or the small castings used between the laminations of generator, motor and transformer cores, which are now made of brass. In such places its nonmagnetic qualities, light weight and small cost make it an ideal material.

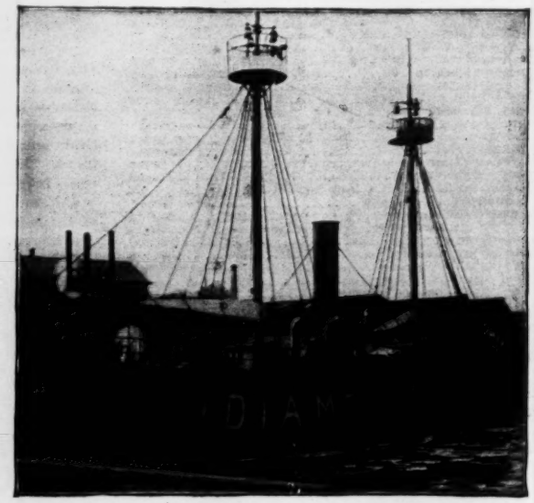
The defects of aluminum must not, however, be lost sight of, and the most important of these are the difficulty of soldering and the increased cost of insulation due to the greater diameter of conduction. In the case of heavy conductors in conduits, this increased size will necessarily preclude its use.

For use in bare transmission lines, however, aluminum seems to be well adapted. This is especially the case where current is transmitted at very high potential. The large surface which aluminum conductors offer would be an advantage in this case, as such currents tend to concentrate on and near the surface of conducting wires.

THE DIAMOND SHOAL LIGHTSHIP, NO. 69.

The lightship here illustrated has now been in position off Cape Hatteras for the last three months, and has successfully withstood the heavy gales of the present winter at that dangerous point. The ship is anchored in 30 fathoms of water, and her general performance has been satisfactory to the Light House Board, as tending to show that a lightship can be safely maintained there and serve as a much-needed beacon and warning for mariners.

Both lightships, Nos. 68 and 69, were built at the Bath Iron Works, of Bath, Me., and No. 68 is now stationed off Fire Island, at the entrance to New York harbor. The same dimensions apply to both. They are strongly built, composite vessels, 122 ft. 10 ins. long over all, 29 ft. 6 ins. beam and 22 ft. molded depth. The two steel masts supporting the electric lights are 64½ ft. high, and each carries a gallery for day signals. The propelling machinery, to be used in steaming to the station or away from danger, is operated by simple, condensing, vertical engines, with 20-in. cylinders, 22-in. stroke and 350 HP., at 150 revolutions. Steam is supplied, at 100 lbs. pressure, by a steel Scotch boiler, 12 ft. 2 ins. diameter and 11 ft. long. Two vertical donkey boilers furnish steam for the electric lighting plant, windlass, pumps, fog-signals and heating. Each vessel is fitted with steam-steering gear, bells, steam winch, anchors, chain cables, etc.



LIGHTSHIP FOR THE DIAMOND SHOALS OFF CAPE HATTERAS.

The electric plant, which is in duplicate, was made by the General Electric Co., of Schenectady, N. Y. Each plant contains two marine generating sets, with dynamo and engine. The four-pole dynamos are 8 kilowatt, 350-revolution machines, directly coupled to 4½ × 4-in. double cylinder engines. These dynamos furnish a 100-volt current to eight 100-c. p. lamps, four at each masthead, and 40 16-c. p. lamps about the vessel. The masthead lights are each enclosed in a lens lantern; of which three are used and one held in reserve. Appliances are employed for breaking the circuit at regular intervals, so that a fixed white light shows for 12 seconds, followed by an eclipse of 3 seconds. The focal plane is 57 ft. above the sea, and the lights will be visible for 15 nautical miles in clear weather. We are indebted to the courtesy of the New York "Tribune" for the photographs from which our illustration was prepared.

THE ATLANTIC CITY MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The winter meeting of the American Institute of Mining Engineers was held at Atlantic City, N. J., beginning on Tuesday evening, Feb. 15. The meetings of the Institute hitherto have been noted for excursions to points of interest to engineers or to lovers of scenery, and for various kinds of entertainment furnished by local committees, to such an extent that the time available for the reading and discussion of papers has been restricted. Some of the members having criticised the management in times past for not providing sufficient time for strictly professional work, an effort was made to change the usual order at this meeting. The place of meeting has no suburbs, save salt water marsh, no features of special engineering interest, and no attractions except the mild winter climate, the great boardwalk, the sea-breezes and the magnificent sun parlors of the hotels. There was no local committee, the members paid their own way and looked after their own entertainment, and it was arranged to have enough professional sessions to satisfy those who had clamored for them. The programme was carried out with one exception. Sessions were set down for both morning and afternoon of Thursday, but at the morning session, which began at the late hour of 11 o'clock, to insure a good attendance, including the late risers, a motion was unanimously passed to dispense with the afternoon session, and to have Dr. Raymond give a half-hour talk before adjournment of the morning session on the papers which were to have been discussed in the afternoon, and to consider these papers as read. The plan suited everyone. The attractions of the sun parlors, of promenading or being pushed in rolling chairs on the boardwalk, or of horseback or trolley car riding through the city were greater than that of sitting out a session, listening to a discussion of such subjects as limonite pseudomorphs or the mining districts of Colombia and West Australia.

It must not be supposed, from what is said above, that the Atlantic City meeting was in any sense a failure either professionally or socially. The papers presented, some printed in advance and distributed to members a week or two before the meeting, others at the meeting, some in the form of galley proofs, and others in type-written manuscript, and still others "read by title," form a fine collection of chemical, geological, mining and metallurgical literature, well worthy of a permanent place in the "Transactions," where they will be highly appreciated by the 2,499 members of the Institute. The Institute has now grown to this large membership, and is receiving accessions of new members every year from South Africa, Australia, New Zealand, South America and other far-off places, who consider their $10 a year well spent, if they receive for it the annual volume, although they can never attend a meeting.

To those who attended the meeting—about 150, including ladies—it was a highly successful one, whether they attended the professional sessions or not. Its especial feature was the large attendance of the "old timers," many of whom date their membership back to 1871, the first year of the Institute. The meeting of old acquaintances, the professional and social chats in cozy corners, the formation of friendships between the newer members and the men with white hairs but with hearts ever young—these are the features which make every meeting of the Mining Engineers a successful one, whether the papers are discussed or only read by title, and measured by this standard the Atlantic City meeting was a great success.

The hotel headquarters were at Haddon Hall, one of the largest hotels in the place; the professional sessions were held in the audience room of the beautiful Casino of the Brighton Hotel, and the banquet on Thursday evening at the St. Charles Hotel.

The session on Tuesday evening was devoted to two lectures, illustrated with lantern views. The first was entitled,

"Mining and the Forest Reserves,"

by Mr. Giffard Pinchot. It consisted chiefly in an exhibition of photographs showing the results of the neglect of proper administration of forests in the Western mining regions. The effect of forest fires and of reckless cutting of timber and the consequent wastes were most graphically shown, and the need for government supervision of the Western forests was strongly impressed on the audience. The second lecture was entitled,

"A Journey in Southern Russia,"

by Mr. S. F. Emmons. It described what the lecturer saw on the excursion of the International Congress of Geologists in Russia last summer. The excursions were tendered to the Congress by the Russian government, and were the grandest and most expensive of any ever had by any scientific organization in the world. Upon the adjournment of the Congress after its meeting in St. Petersburg, the whole party was taken to Moscow, and there it divided into three parties, one of which went westward to the Ural mountains and into Siberia, thence southward into the Caucasus mountains and across them into Armenia; another went to Southeastern Russia, and the third went directly to the Caucasus. Mr. Emmons was in the third party. His lantern slides gave some magnificent views of Russian scenery, and a good idea of the appearance, manners and customs of the various peoples.

No session was held on Wednesday morning, but the time was well used in scientific and other conversations in the numerous parlors and halls of the hotel. In the afternoon session the first paper was,

"An Automatic Device for Gas Producers,"

by C. W. Bildt, of Worcester, Mass. A working model of the device was shown. It feeds the coal into a circular gas producer at a regular rate, which may be changed at will, and distributes it evenly over the level surface of the bed. The device is remarkably ingenious, and it seems to be the most important improvement in the gas producer that has been made in many years. We shall give an abstract of this paper in another issue. The next paper was entitled,

"An Apparatus for the Removal of Sand from Waste Water of Ore Washers,"

by J. E. Johnson, Jr., Longdale, Va. It describes a system of revolving shovels, operated by power, which remove from settling tanks the sand which is carried away in the waste water from the ore washers used almost universally in the South for the brown iron ores. The sand is largely composed of fine iron ore, which may some day be utilized, and it helps fill up the clay settling ponds, which are expensive, and tends to choke the troughs leading from the washers to the pond, so that hand labor hitherto had to be employed to shovel them out. By using the power shovel, a cheaply built device, to remove the sand before it enters the trough, the inclination of the latter may be made less, increasing thus the available depth of the settling ponds. These do not fill up so rapidly, and the labor of shoveling out the troughs is saved.

This paper was discussed briefly and favorably, and was followed by a paper by Prof. H. M. Howe, entitled,

"Notes on Certain Diagrams, Graphically Illustrating Important Thermal and Structural Conditions."

Two diagrams were shown, the first exhibiting the relative proportions of the microscopical components or minerals constituting iron and steel of different degrees of carbonization, known to students of iron and steel micrometallography as ferrite, pearlyte, hardenite, martenite and cementite. The second was an application of the equilateral triangle method of graphical illustration, which was first used in 1877 by Prof. R. H. Thurston in illustrating the strength of triple alloys of copper, tin and zinc (Trans. Am. Soc. C. E., Vol. X, 1881, p. 1). Prof. Howe applies it to graphically recording the melting points of silicates of lime and of alumina or of other components of three elements or proximate constituents. In the discussion of the paper Mr. Wm. Kent stated that he believed that Prof. Howe's use of the equilateral triangle method was the first new use of it that has been published since Prof. Thurston showed how it might be used in various kinds of researches. He (Mr. Kent) had recently suggested its use in the study of the nature and treatment of different kinds of boiler scale, using one triangle to represent the relative percentage compositions of sodium, lime and magnesia, and another to represent chlorine and sulphuric and carbonic acids, but had not yet had an opportunity for publishing an illustration of such a use of the method.

The last paper of the session was,

"Notes on the Bertrand-Thiel Process,"

by Joseph Hartshorne. It had not been printed in advance, and was read from the manuscript by Dr. Raymond, in the author's absence. It gave a record of progress of the process at Kladno, in Austria, referred to recent reports of it published in England, and stated that it was being introduced at Creusot, in France, Charleroi in Belgium, and at two works in Luxembourg and Hungary.

This paper was followed by another read by Dr. Raymond:

"Notes on the Stockholm Exposition and the Iron and Steel Trade of Sweden,"

by James Douglas. It was a highly interesting description of the author's observations, and gives the impression that Sweden is a good deal in advance of other parts of the world in some features of its iron and steel industry. Its tonnage of finished product is not great, but the quality is of the very highest grade, and Mr. Douglas's statement that Sweden is likely to become the second largest producer of iron ores in the world, the United States being first, is something of a surprise. We quote a few extracts from the paper:

The Kopparberg exhibit illustrated also the subsidiary industries which have grown up around most of the prominent mines of Sweden. Not only does the same company mine the ore and reduce it to metal, but it converts the metal into highly specialized forms, and thus combine manufacturing with mining and smelting.

Besides such industries, lumbering and the making of wooden pulp and paper have become auxiliaries to several of the iron works. As coal or coke, being more or less tainted with sulphur, is scrupulously excluded from their iron works, charcoal is exclusively used in the blast furnaces and wood producer-gas in the open-hearth furnaces. Enormous quantities of wood are therefore consumed as fuel. But as inferior lumber is suitable for charcoal and the refuse of the lumbering camp and of the saw mill can be converted into gas, it has been found profitable to sort the lumber into three grades, the best going to the pulp mill, the second quality being sawn into lumber, and the poorer grades only being used as fuel.

The company's operations extend over three provinces. They own 736,000 acres of forest land, which is traversed by 1,700 miles of lake and water courses. It would seem that they cut over about five acres to the ton of product.

At the Monkfors works I understood that an area of 200,000 acres supplied first-class wood for pulp, second class for lumber and third class for the manufacture of about 30,000 tons of product, which would be at the rate of about seven acres per ton of finished iron and steel. There, also, part of the iron left the works as pig, and part in highly finished forms of steel and iron.

The Crown forests, which cover some 8,000,000 acres, or one-sixth of the forest land of Sweden, are scientifically cut over and preserved, and the forest domains of the large iron companies are also scrupulously husbanded, only the increase being cut. A very large tree is seldom seen in Sweden, as it is found most economical to cut spruce and pine after forty years' growth, when the butt has attained a thickness of from 8 to 10 inches.

At Koppaberg, the charcoal is burned in a continuous kiln at a cost of 33% less than that of heap-burning, and with 22% higher volume of yield.

The sawdust from the mills, bark, twigs, and every particle of combustible vegetable matter, is made into gas in producers.

The purer iron ores, with phosphorus as low as 0.0045%, are those which maintain Sweden's reputation; but though most of the highly phosphoric ores of the province of Kopparberg are exported (namely, in 1896, 550,000 tons out of a total output of 639,000 tons), the balance is made into very superior iron by the Thomas-Gilchrist process with wood fuel.

The Swedish ironmaster prefers, however, to restrict his operations to the production of small quantities of highest grade material rather than to aim at a large output of inferior iron and steel. The national statistics clearly demonstrate this.

Even the famous Sandvik Co., whose steel tubes are celebrated in this country for bicycle frames, makes only about 20,000 tons of steel annually. But the utmost care and supervision is exercised, and hand labor is employed to an extent which is profitable only when expended upon material of such value. Every wire bar is carefully inspected, and men with hammer and chisel cut off every particle of scale or burnt surface.

While, however, the iron and steel-making and manufacturing from pure ores is conducted on what we would consider a very limited scale, the mining and exportation of ores of impure quality, though of high percentage, is assuming very large proportions. The largest exportation will be from the mines in the northern provinces, which are as yet almost uninhabited, but which are known to conceal enormous deposits of iron ore of non-Bessemer grade. At the Exhibition there were striking exhibits from the Gellivara group of mines, on deposits which vie in size with the largest of our Lake Superior iron ore masses. In another respect they resemble some of our Lake Superior mines, in that the ores can be classified into grades with variable amounts of phosphorus, the grades varying from 68% of iron and 0.05 of phosphorus, to 60% of iron and 1.5% phosphorus. As yet the ores have been shipped from the port of Lulea, on the Baltic, and have found their most accessible market in Germany. (At Stettin very large iron and steel works have been recently erected to be fed entirely with imported ores.) At Lula the company has built a concentrating plant of the capacity of 100,000 tons annually, with the double purpose of making a high-grade magnetite and separating the apatite as a valuable by-product. A wider market, however, is being sought for the ores, and to this end a railroad has been projected across the neck of the peninsula to the coast of Norway, where the ports are open the year round, and where large works will be erected. The railroad will tap other large deposits of ore in this hyperborean region (67° to 68° N. lat.), and therefore Sweden may be counted on as likely to become, in the near future, the largest producer of iron ore in the world, next, of course, to ourselves. Her production of ore in 1896 was 2,038,096 tons, and her exportation from the Kopparberg and Gellivare mines alone reached 1,175,000 tons.

Of all the wonderful objects exhibited by the many companies which displayed their wares in Stockholm, the most striking were the cold and hot-rolled bands made by the Sandvik works. At present the Sandvik works supply the world with a very large portion of its "Paragon" umbrella-ribs; but their ribbons of steel illustrate more expressively than do their umbrella-ribs what can be done with pure steel. In the Sandvik pavilion a band of cold-rolled steel of No. 26 gage, 2,354 ft. in length and 8 ins. in width, weighing 1,146 lbs., was coiled like a frame around the objects displayed upon the walls, and hung in graceful festoons from the roof. There was also exhibited a band of No. 49 gage, weighing 43 lbs., 2⅝ ins. wide, 4,317 ft. long, and which was, therefore, about 0.00125-in. in thickness. The same band saw which attracted attention in Chicago (No. 14 gage, 220 ft. in length, weighing 677 lbs.) was exhibited, and they showed a strip for lap-welded tubing of No. 6 gage, 21 ft. wide, but with perfectly true square edges. This company also exhibited with pride a hot-rolled band of No. 8 gage, 8 ins. wide and 298 ft. long, weighing 2,140 lbs. This, they claim, is the heaviest and longest band rolled in one heat of such width and gage from a bloom 4⅜ ins. thick and 11 ft. long.

A prominent place in their pavilion was given to their hollow blooms for the manufacture of bicycle tubes, samples of which, up to 8 ins. in diameter, were displayed with excellent effect.

Perhaps the most startling exhibit was that made by the Laval Steam Turbine Co., whose engines are now built with much more skill and operated more economically than when they made their modest debut at Chicago. At their manufactory at Jerla, near Stockholm, I saw their engines running under a pressure of 225 atmospheres, though at Stockholm they did not venture to raise the steam quite to that high pressure. The engines are certainly models of exquisite workmanship. As at present sold, they are run under a steam pressure of 180 lbs. of dry steam, but within two or three years the company expects to have so perfected its high-pressure boiler as to warrant its being offered to the public with assurance of safety. The boiler consists, I believe, of a 1-in. coil, in which a very small quantity of water is evaporated under this enormous pressure, the condensed steam after use being always returned to the boiler. If a coil should burst, the steam, which is small in quantity, expands its energy innocently within the ample shell which encloses the coil. The engines and boilers, as now sold, are said to work with an expenditure of 2 lbs. of good coal per horse-power, but under extreme pressure this consumption is said to be reduced to 1.5 lbs.

At the session on Wednesday evening two more lectures were given with lantern illustrations. The first was:

"The Cranberry Breaker, Hazleton, Pa.,"

by Mr. W. S. Ayres. It described an entirely new method of building the wooden framework of an anthracite coal breaker. It was so constructed that compressive stress across the grain of the timber, its weakest direction, was entirely avoided. The method cannot well be shown without the drawings, which are not available. It was followed by

"Notes on the Ural and Caucasus,"

by Dr. Pusifor Frazer, who was one of the geologists at the International Congress at St. Petersburg. His party went from Moscow to the Ural and thence to Caucasus, and his description and views of the places seen were extremely interesting and often highly amusing. The party saw the grandest mountain scenery in Europe, and the most mixed variety of races, and experienced the most lavish hospitality that can be imagined, besides escaping the dangers of brigands (from which they were protected by an escort of mounted soldiers), of wild drivers of droskies, and of champagne without limit at every meal.

Thursday morning's session was taken up with the rapid presentation of a large number of papers and the brief discussion of a few of them. The first was,

"A New Form of Ingot Mold for Brass or Bronze,"

by Erwin S. Sperry, Bridgeport, Conn. The mold described has a lip for grasping it by the tongs on one end only, the other end flaring outwards at the bottom, so as to prevent the mold's tipping when the crucible rests on it. Several advantages are claimed for the improved form, which Mr. Sperry has used for several years.

This was followed by

"The Influence of Antimony on the Cold-Shortness of Brass."

by Erwin S. Sperry, Bridgeport, Conn. This paper describes a series of experiments made by adding varying amounts of antimony to brass composed of 60% copper and 40% zinc, and testing the products by examination of the fracture of the cast material and by rolling. The purest Lake copper and refined zinc were used. The paper contains photographs of the fractured ingots, showing that the fractures of all the alloys containing 0.02% or upwards of antimony are highly crystalline, while those containing 0.01% or less are fibrous. The rolling tests indicated that the alloy containing 0.02% of antimony was on the dividing line between good and bad rolling material. An alloy containing 0.67% antimony was rolled from 0.468 to 0.431-in., a reduction of 8%, when it cracked in many places. On being further rolled to 0.410 the plate cracked to pieces. It could not be forged at any temperature. An alloy containing 0.10% antimony checked on both sides when reduced from 0.655 to 0.560-in., or 14% in thickness by rolling. It was annealed and rolled to 0.476-in., a reduction of 15%, annealed again and reduced to 0.385-in., or 17%, and annealed a third time and reduced to 0.288-in., or 25%. Cracks appeared at each rolling, and so many cracks formed in the last rolling that it could not be formed any further. It could be forged hot to a thin edge and bent over on itself and flattened without showing any cracks.

An alloy containing 0.05% antimony was somewhat better than the one containing 0.10%, but on the first rolling it checked on both sides of the plate when 13% reduction was reached. Two alloys, each with 0.02% antimony, the first containing 60.06% copper and 39.92% zinc, and the second 62.02% copper and 57.96% zinc, were made. They rolled without difficulty, but so many checks and cracks appeared that they would undoubtedly cause more or less trouble in practice. Two ingots containing 0.01% antimony and one containing no antimony, were made, and all proved to be good rolling metal. The following table gives a summary of the results of tests of the tensile strength, etc., of the several alloys:

Summary of Tests of Brass Containing Antimony.

	Per cent. of antimony in brass.	Tensile strength per sq. in. lbs.	Elongation in 8 ins., %	Reduction of area, %	Possible reduction in rolling, %
Sheet	0.67	....	..	..	8
Sheet	0.10	....	..	..	25
Annealed sheet	0.05	56,600	21	27	52
Annealed sheet	0.02	58,800	34.5	45	64
Annealed sheet	0.02	53,800*	43	58	76
Hard rolled sheet	0.02	105,700	0.25	8.4	..
Annealed sheet	0.01	61,800	36.3	46	82
Hard rolled sheet	0.01	102,000	2.4	37	..
Annealed sheet....A	0.01	61,200	33.2	43.7	85
Annealed sheet....B	0.01	60,620	34	43.8	..
Hard rolled sheet	0.01	109,000	0.6	16	..
Annealed sheet....A	0	58,700	35	43.9	85
Annealed sheet....B	0	61,300	33.3	43.7	..
Hard rolled sheet	0	111,000	0.75	15	..

*Flaw in metal.

The following are some of the conclusions reached by the author:

The fact that antimony is an injurious impurity in brass has been known for some time. Keri says that experiments carried out in England showed that the presence of as small an amount as 0.001% of antimony in copper renders it unfit for the manufacture of brass sheet or wire. This figure is abnormal, and the discrepancy between it and that given above as the limit is probably due to the presence in the brass or copper of other impurities, the effect of which was charged to the antimony.

From the experiments reported above, it is evident that high brass cannot contain more than 0.01% of antimony and roll satisfactorily; and specifications for copper to meet rigid requirements should limit the contents to that amount, thus giving only about 0.006% in the brass—a safe amount, providing no other impurities are present. Low brass, on account of its natural softness, is not as susceptible to impurities as high brass, but the rule given will hold good for brass containing between 60 and 70% of copper.

Antimony is an inseparable impurity in electrolytic copper, and is partially responsible for its unpopularity. While the best brands of such copper ordinarily do not contain enough antimony to injure brass, oftentimes the content of this element will be so high as to render the process of rolling difficult or uncertain. It is this factor of uncertainty which prevents the universal adoption of electrolytic copper for making brass. Otherwise it would be deemed equal in quality to Lake Superior material.

There seems to be a similarity between the manufacture of basic steel from high-phosphorus ores and the production of copper from ores rich in antimony. In the majority of instances the product is normal; but sooner or later a condition arises which allows a product to become contaminated with the impurity in question, and after a trial by the consumer it is of course condemned. As most copper is used by the consumer without testing, a few experiences of such a nature suffice to hinder any further use of the commodity. The fact that various samples of electrolytic copper contained from 0.001% to 0.08% of antimony as the results of many determinations, will serve to illustrate and confirm the above statement.

The next paper was,

"The Elimination of Impurities from Copper Mattes in the Reverberatory and the Converter,"

by Edwin Keller, of the Baltimore, Md., Copper Works. This is a most important paper for the copper refiners. It shows quite conclusively the advantages of the process of bessemerizing copper matte, which has now practically superseded the reverberatory process in this country for the removal from the copper of the hurtful impurities. A direct comparison is made of the value of

the two methods for the refining of matte from the Anaconda Copper Co.'s works in Montana, that company using the converter process, while the reverberatory process was used on the same matte by the Baltimore company. The paper was discussed by Dr. E. D. Peters, author of a well-known work on copper smelting, who gave an account of a process now used at the Britonferry works in England, which has advantages over the converter process. In it sulphide of copper and copper oxide are brought together in a fused state, and a violent reaction at once takes place, the oxygen burning the sulphur to sulphurous acid gas, which escapes, leaving the copper in a refined state.

The discussion of this paper was followed by a brief note on

"The Strength of Wooden Beams Calculated from Compression Tests,"

by B. E. Fernow, of the U. S. Forestry Bureau. Mr. Fernow has discovered a remarkable relation between the results of endwise compression tests of timber and transverse tests of beams, viz.: that the transverse strength of the beam at the elastic limit is proportional to the ultimate compressive strength. The results of his tests will be published shortly in a bulletin of the Forestry Bureau.

This paper was followed by the reading of written discussions by Mr. Fernow, and Professors J. B. Johnson and Jacoby, on Mr. Edgar Kidwell's paper on the "Efficiency of Built-Up Wooden Beams," which was presented at the last meeting of the Institute, and the substance of which has also been presented by Prof. Kidwell in contributions to Engineering News.

The remaining papers on the programme were then read by title, and a brief statement of their contents was made by Dr. Raymond. The list was as follows:

"The Kotchkar Gold Mines, Ural Mountains, Russia," by H. B. C. Nitze and C. W. Purington; "Note on Limonite Pseudomorphs from Dutch Guiana," by R. W. Raymond; "The Ultimate and the Rational Analysis of Clays and Their Relative Values," by Henrich Ries; "Emery, Chrome-Ore and Other Minerals in the Villayet of Aiden, Asia Minor," by W. F. A. Thomae; "Mining Districts of Colombia, S. A.," by Henry G. Granger and Edward B. Treville; "Kalgoorlie, Western Australia, and Its Surroundings," by George Bancroft; "The Manganese-Ore Industry of the Caucasus," by Frank Drake; "Some Peculiar Occurrences of Gold-Ore in Montana," by W. H. Weed; "Tennessee Phosphates," by Lucius P. Brown; "Sectional Crushing Rolls," by J. W. Pinder; "Stamp-Mill Indicator Diagrams," by Henry Lewis; "The Gold Deposits of Siberia," by Rene de Batz.

Announcement was then made of the results of the election of officers for the ensuing year as follows: Pres., C. Kirchhoff, New York city; Vice-Presidents, E. D. Peters, Jr., Dorchester, Mass.; A. R. Ledoux, New York; Leon P. Feustman, Mexico City, Mexico; Managers, R. P. Rothwell, New York; W. J. Olcott, Duluth, Minn.; W. B. Devereux, Glenwood Springs, Colo.; Treasurer, Theodore D. Rand; Secretary, Rossiter W. Raymond.

On Thursday evening a banquet was held at the St. Charles Hotel, and on Friday morning an excursion was taken to Philadelphia. On arrival at the wharf, carriages were taken to the Commercial Museum, on Fourth St., where two hours were spent in looking over the exhibits and in listening to a lecture by the Director, Prof. Wilson, on the purposes of the museum. The party then went to the Manufacturers' Club, on Walnut St., where an excellent luncheon had been provided by the courtesy of the club, and the freedom of the club rooms was granted to the party for the rest of the day.

ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF BRICK MANUFACTURERS.

The twelfth annual convention of the National Association of Brick Manufacturers was held at the Monongahela House, Pittsburg, Pa., Feb. 15-18, 1898. President William H. Brush, of Buffalo, N. Y., presided, and the delegates, of whom there were 300, were welcomed by Mayor H. P. Ford. The convention was the most successful ever held by the Association. The first session of the convention was taken up with routine business and a discussion under the heading "Looking Forward."

A committee on "Statistics and Value of Brick as a Building Material," consisting of Messrs. W. C. Ogden, Binghamton, N. Y.; J. E. Clapp, Vicksburg, Miss., and C. H. Merrick, Syracuse, N. Y., was appointed.

The following officers were elected for the ensuing year: President, William Flynn, Pittsburg, Pa.; First Vice-President, Lee J. Howard, St. Louis, Mo.; Second Vice-President, William Conway, Philadelphia, Pa.; Third Vice-President, Elliott S. Morse, Berlin, Conn.; Secretary, T. A. Randall, Indianapolis, Ind.; Treasurer, John W. Sibley, Birmingham, Ala.

Topical Discussions.

The first business of the second session was a discussion of the question, "Will Any Salmon Brick Withstand Exposure to Freezing." There seemed to be a considerable difference of opinion among the various members as to just what was meant by a Salmon brick, and the evidence submitted by members from different parts of the country made it pretty clear that color alone was not a criterion of the partly burned, soft brick which generally goes under this name. It was also stated by some of the members that the "ring" or sound of the brick was also not always a reliable indication. The general concensus of opinion, however, seemed to be that the partially burned soft brick, designated in some places as Salmon brick, on account of its light red color, would not withstand exposure to freezing.

"How Much Water Can a Brick Absorb and Yet be Safe from Frost Disintegration," was the next question discussed. Mr. G. M. Fiske, of Boston, called attention to the discussion of this question in a paper read before the Ohio Clayworkers' Association, about a year ago, by Prof. Edward Orton, Jr., of Columbus, O. This paper, he stated, indicated that there were so many conditions entering into clay, and the process of hard burning and soft burning, that it was impossible to set down any rule as to how much water a brick might absorb and yet be safe from frost disintegration. In response to a request Prof. Orton made the following remarks upon the question:

I do not think I can throw any light on the situation more than was given in the paper a year ago at the Ohio Clayworkers' meeting. That paper was devoted to showing the great variations in conditions which will affect this question of absorption. We have one new point since I wrote that paper. I got it from Prof. Welsh, of the Missouri Geological Survey. He said that in his experience it made a difference as to how the brick was to be situated, as to whether it would stand freezing. A brick which would stand a large percentage of water perfectly well, when laid on the ground and frozen, could not stand it if set on a block and frozen. He said that if it is set upon a block the frost will strike it practically from all sides at once. It forms a film of ice surrounding the entire surface, and as it thickens and deepens into the surface it forms an impregnable layer through which the interior water must expand. Consequently, a brick will almost invariably burst if it is supported in that way in freezing weather; but laid on the ground it will freeze from the top downward, the ground protecting the bottom side from freezing, and the water crowding through the bottom pores. It is impossible to set a limit at which freezing will burst a brick. You cannot set any such limit. It depends on the clay and how it is made; but it is not uncommon to find cases where a piece of clay will absorb 20% of water and stand freezing afterwards.

Mr. W. A. Eudaly, of Cincinnati, O., stated that his experience tended to contradict the assertion made by Prof. Walsh.

The next question to be discussed was, "Does Not Saltpeter Injure Salmon Brick as Much as Frost." Although the discussion was somewhat irrelevant the general tenor of opinion was that saltpeter was an injurious constituent in brick and rapidly hastened their destruction.

The question, "Does Age Improve the Resistance of Brick to Abrasion, when the Brick is in Use or Under Cover and not Exposed Directly to the Weather," was introduced by Mr. J. W. Carson, of La Prairie, P. Q., who gave the following record of experiments made by him to decide this question:

(1) We took a block of brick direct from the kiln. Half of these we tested by putting them direct from the kiln into the rattler, the other half we soaked for 24 hours and then put them into the rattler without any drying. The result was greatly in favor of the soaked bricks.

(2) We took a block (also side cut) from a pile on the yard, exposed to the weather. Half of these we rattled direct; the other half we dried in our kiln for about 14 hours, allowed them to cool, and then tested them in the rattler. The result was in favor of the brick direct from the yard.

Our end cut brick tested on the latter basis showed a corresponding variation. Further, to satisfy ourselves, we procured a batch of foreign paving bricks, and followed the same course, with a like result, though not quite so pronounced as with our own brick.

Mr. J. W. Fisher, of Montreal, P. Q., stated that he was associated with Mr. Carson in the tests described and confirmed all his statements.

Prof. Orton, Columbus, O.—In view of the standard rattler test work which was done for the association a year ago, and inasmuch as I was responsible for that particular part of the test, I naturally took very deep interest in the communication which Mr. Tester sent me some weeks ago. We discussed in the meeting of the Commission the question as to what effect the rattler test might have on the absorption test, but no heed was taken as to what effect absorption might have on the rattler, so that the communication was entirely novel, and I was not disposed to accept the statements as entirely straight, until Mr. Tester sent me the results in full, carefully worked out. I at once realized the enormous importance of this discovery. It was of great practical importance and technical interest if it could be verified, and there is the point.

I have in my laboratory the remains of brick which we procured for the experimental work in determining the standard tests. They were unloaded and stored in my laboratory, and have been there in a temperature of 70° in winter and about 60° in summer. I do not know what effect age may have had on that brick, but I do know that the rattler test they give now in the dry condition is substantially the same as two years ago. It has not changed enough for me to detect it. I know that the difference is very small, if any really exists. Bearing out Mr. Tester's argument, I took 16 charges of brick, 22 bricks each. The first four of them I made up and put in the rattler, and determined their loss by abrasion, in the regular standard method. I found an average loss of 27.3 of the brick dry. I then took four charges and soaked them in water from seven to ten days, immersed all that time. I took these direct from the water and wiped them dry, and weighed them to determine the absorption. It was about 1% in 10. I rattled these four charges and found an average loss of 25.14. I then took four charges, soaked them in water from seven to ten days, and put them outside of the building on the canvas and left them out 36 days, during which time they were exposed to two blizzards and two thawing spells and considerable rain. They had an opportunity to dry out some and to soak up further water, and they were frozen while wet, as wet as they could be, holding as much water as they could contain. When they came in they were not frozen. Four charges of these tested with an average loss of 23.86. Taking the loss on the four charges of dry bricks, as a standard, calling that 100%, the charges which had been soaked only lost 92%; that is to say, we have gained 8% on the test by soaking, and by the exposure of 36 days to the weather we gained 12%. I put out four charges treated in the same way, exposed to the weather, and my object was to keep them out there until a good freezing spell came, and bring them in while full of frost; but my helper, in an excess of zeal, got two of the batches tested before I knew it. The average of the first four charges, above referred to, was 23.86. The average of the last two was 23.88. The two other charges, still remaining, I still have out, and will leave them six months before testing.

I want to say to the association that I spoke a moment ago about the probable necessity of revising our paving brick test, or directing the paving brick commission for a time to take cognizance of new points; and I had this matter in mind, but it is not likely that this will be the only new matter. We did the best we could with the paving brick commission a year or two ago, and are not ashamed of the results; but it is likely that such things as these will crop up all the time, and we will not get to the end of it at once.

Noise from Brick Pavement.

The next question, "How Can the Element of Noise in Brick Pavement be Obviated or Minimized?" was introduced by Mr. C. H. Merrick, of Syracuse, N. Y., who said:

In a conversation with Mr. Breed, the manager of the New York Brick & Paving Co., of Syracuse, he spoke of this point, and among other things he said that he believed, in fact, that he was satisfied, that the rumbling noise coming from a brick pavement was caused by the shrinkage of the cement under the brick; that the pavement is frequently laid quickly over green cement, which shrinks more or less, leaving a small space under the brick, thereby making the rumbling noise as the vehicles pass over it. The remedy, in his opinion and mine, is that the cement when put down should be left until thoroughly dry. Then place your pavement over it, and you will get rid of a large amount of noise, if not all. Then you will have a pavement which will give as little noise as the asphalt.

Mr. T. A. Randall, Indianapolis.—The first block of brick pavement in our city was laid on concrete foundation, with nothing between the concrete and the brick pavement. I am confident—though it has not been taken up to demonstrate it—that the concrete has shrunk from the brick, and the curbs have held the brick in place, and the shrinking of the concrete has caused a hollow. There is an alley running across one end of the block, and an exceptionally heavily loaded wagon ran across the pavement, and where the wheels crossed there was a depression. If the foundation had been rigid the wheels would not have gone through the pavement in that way. I am confident, as Mr. Merrick says, that the cement shrinks away. The pavement I refer to was literally a soundingboard, and became very objectionable.

Mr. W. A. Eudaly, Cincinnati.—I saw a street in Columbus, Ohio, exactly as Mr. Randall represents. The concrete had shrunk away from the brick, and immediately on striking that part of the street there was a roar, and on another part of the street it was not so, although it was a brick pavement.

Mr. A. Ittner, St. Louis.—My theory is this: The brick are laid against the curbstone, and the earth under the sidewalk when it freezes expands, and, of course, it expands towards the roadway from each side, and as this expansion takes place in the earth under the sidewalk it crowds the pavement in the street up. I believe that is what causes the rumbling. It is only, so far as my experience goes, in the winter time that this rumbling sound occurs, and it is because the expansion of the earth under the sidewalk causes the pavement to lift from the concrete, and not that the concrete goes down.

Mr. J. H. Chambers, Philadelphia.—I have knowledge of pavements in Wilmington, Del., laid as Mr. Randall describes, but in addition to that the upper course of brick was covered with liquid cement, which ran into the interstices between the brick. The noise was very evident both winter and summer. The city engineer suspected that the cause was what Mr. Randall has surmised, and he took an opportunity to have the street broken to examine the pavement, and he found that the concrete preparation had sunk away from the upper course of brick.

Mr. D. V. Purington.—There is one thing in regard to the noise which has occurred to me many times. I find that if the interstices are filled with sand, the noise is much less than where they are filled with pitch or cement, for the reason that the pavement becomes homogeneous when the pitch or cement is put in, and there is a resonance which you do not obtain when each brick is embedded in sand.

Mr. Chas. A. Bloomfield, New York City.—Mr. Ittner is right when he says that the earth under the sidewalk will expand, and it is for the reason that in the Fall of the year the earth absorbs moisture and the frost throws it out of line, and it raises the street in the center and produces a hollow under the pavement in the form of a drum.

Mr. O. N. Townsend, Zanesville, O.—If brick makers would advocate the use of a filler which is not so rigid we would have less noise, no matter what the foundation is. Sand filling is cheap and not so rigid, and with it you will not hear the noise so much. Tar filling is the same thing. When you have a rigid filler like Portland cement you will have the noise whether you use a stone or concrete foundation.